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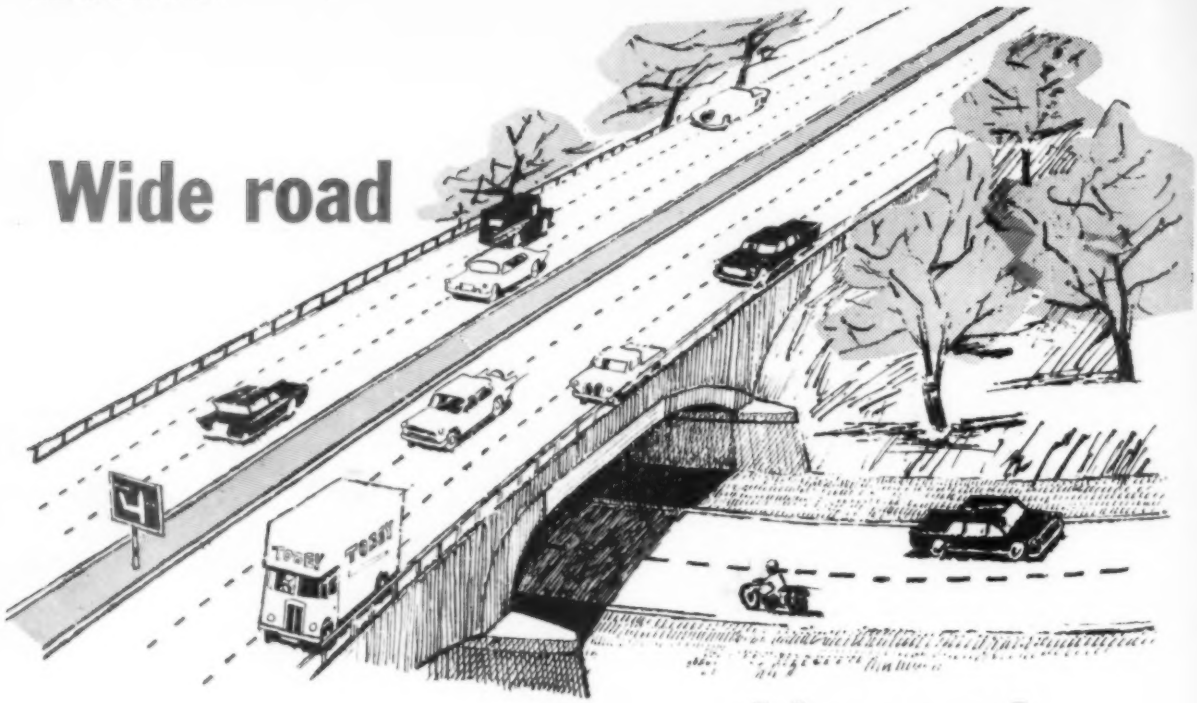

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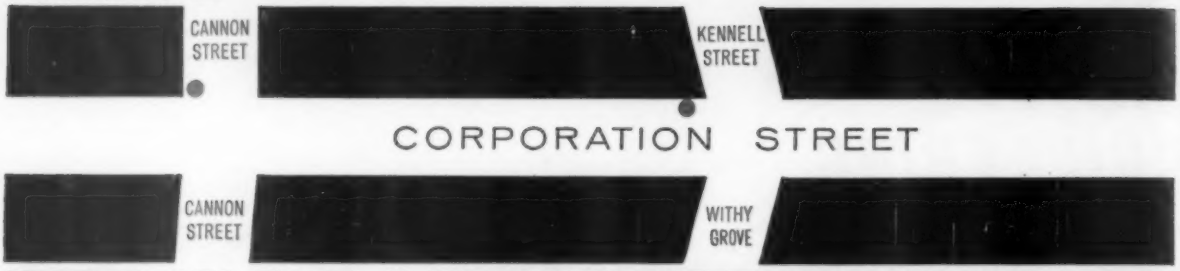

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Mr. Marples' Plans

THE Minister of Transport called a press conference last month to outline plans for London traffic, but he also used the occasion to present his views on roads and traffic problems as a whole. Mr. Marples gave as the general heads under which he claims he is dealing with the situation as, first, roads as a whole between towns—motorways and trunk roads—which are being dealt with under the roads programme; second, roads within towns, which he put under three sub-heads: first, existing streets where the objective was to keep the traffic on the move by removing obstacles to its smooth flow, which meant regulation of short-term and provision of off-street parking, loading and unloading bans, the establishment of clearways, reduction in right-hand turns, introduction of one-way streets, etc. Second, short-term improvements, such as the removal of bottlenecks; and, third, long-term improvements, which were dependent upon the collection of traffic data and, particularly, origin and destination surveys. The Minister's final main head was the rebuilding of the towns, the whole conception of which, in his view, had to be changed. So far so good. Here is the acceptance of the principal methods and techniques of traffic engineering in association with the planners and the other professions concerned.

As far as London is concerned, the Minister is the traffic authority, and to deal with its particular problems he appointed early last year the London Management Traffic Unit with Dr. George Charlesworth at its head. It now has a staff of 100, and its efforts to improve flow on existing roads are beginning to bear fruit. As long, however, as there are over 100 separate highway authorities in the London Traffic Area, despite the greater powers given the Minister under last year's legislation, its speed of work is bound to be as slow as London traffic itself.

Short-term improvements are the responsibility of the London County Council and, with the programme stepped up to £10 million a year—but still inadequate—some major improvements are under way and some bottlenecks are being removed. Despite Mr. Marples' claim to the contrary, London's traffic is still not being tackled as a whole, and cannot be until the projected London traffic survey provides the data on which London's future needs can be assessed and plans drawn for meeting them on a sound scientific basis. This survey, which the Minister claims is to be the most comprehensive ever to be undertaken for so large an area, was first announced early last year, and was expected to be started at latest by this spring. Argument over its extent and cost between the Ministry, the Treasury, the L.C.C. and the consultants is apparently still going on, and all the Minister could say at his press conference was that it was hoped to start it later this year and that, with the use of electronic computers, the results should be known 18 months later. The delay in undertaking the survey is inexcusable. Since its objective is to provide data to make reliable projections some 10 or more years ahead, on which the planning of the Greater London area, around and within which one-fifth of the country's population circulates, can be based, it is immaterial whether the survey costs one-quarter or one-half million pounds. It is vital that it be comprehensive, and that requires adequate sampling both by home and roadside interview to ascertain travel habits and desires, origin and destination of traffic, journey times and desire lines, and all that is required to plot future needs. If by cheese-paring the survey is so cut that it provides only partial information about present traffic movements, which is insufficient to enable accurate projection into the future, then both time and money will be wastefully spent; false economy will have been engaged in. A quick decision to go ahead is essential so that the survey can proceed before the most suitable time for field work has passed; otherwise, some schemes may go forward which subsequent information will show should not have been given their present priority or could have been better dealt with.

Outside the Metropolis, the Minister's authority is limited and, in the short term, all he can do is to encourage and persuade the responsible authorities in urban areas to follow London's example, as far as it is applicable to their particular problems. But, in the long-term, his advice can be invaluable in regard to urban development, provided it is well based. To this end, Mr. Colin Buchanan was transferred from the Ministry of Housing and Local Government to the Ministry of Transport about a year ago, to examine the whole question of urban roads and planning and a study group has been set up to assist him. Here again, it is essential that every assistance be given to enable the task to be completed with speed and efficiency since, as the Minister himself has stated, many large areas will shortly be falling in for renewal and the occasion to deal effectively with them may never recur. The longer the delay in giving the necessary guidance, the greater the danger that redevelopment will take place piecemeal, the needs of traffic in relation to land use not fully appreciated and provided for, and the opportunity which now presents itself for the intelligent and scientific re-planning of our towns and cities, will have been lost to the inevitable regret of future generations.

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this is King Edward Street–Huntingdon Street

where signals control this busy intersection for vehicles and pedestrians

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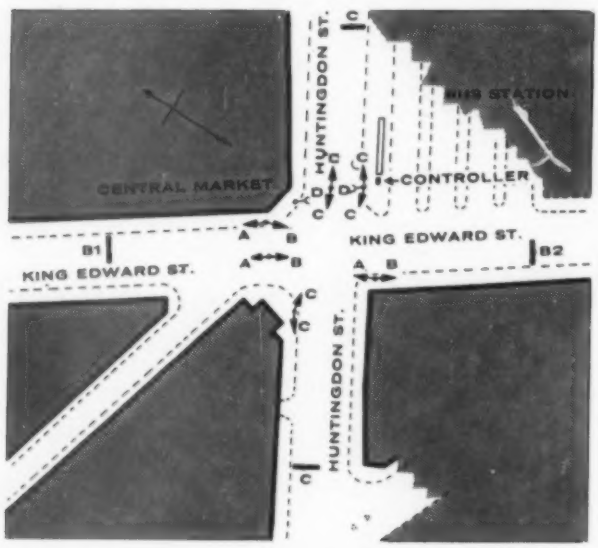
Large numbers of pedestrians cross between the Bus Station and Market area and the inclusion in the installation of pedestrian operated signals has provided complete protection for both the pedestrian and driver.



Phase A is a short period which allows traffic from King Edward Street North to establish itself against traffic from the South side waiting to turn right. This latter traffic waits during Phase B and is released so that it can flow without hindrance during Phase BX. During Phase C traffic from Huntingdon Street is released in both directions after which Phase D is given in correct sequence provided one of the two pedestrian push buttons has been operated.

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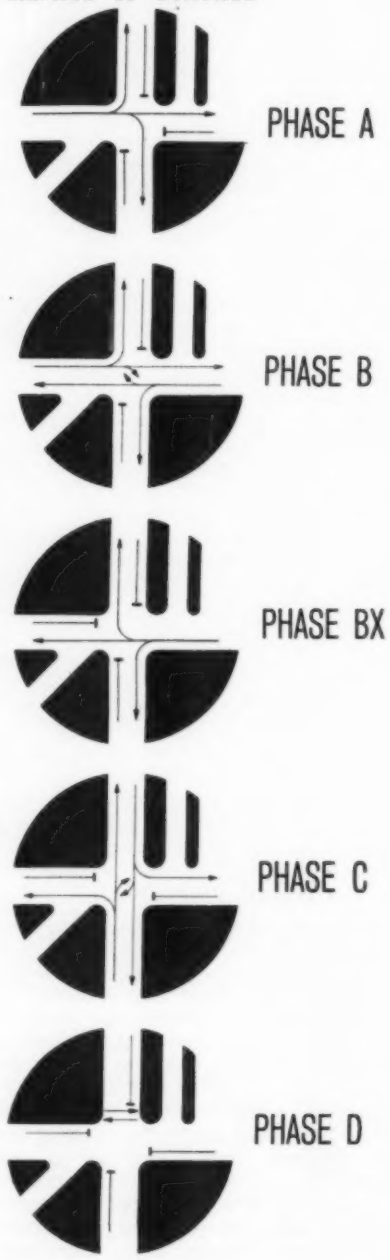

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Topics of the Month . . .

THERE have recently been indications of an increasing and gratifying appreciation of the inevitability of providing adequate parking facilities within urban areas, in preference to attempting to hold back the flow of vehicles into the centres of social and economic activity. Three instances are given in later pages: Enfield's proposals for ringing with on and off-street car parks the Town Centre, converted into a traffic-free pedestrian shopping precinct; the opening of the first fully automatic multi-storey garage, the Autostacker, at Woolwich, and the private development of the Bull Ring shopping centre in Birmingham. Both Enfield's plan, which was preceeded by comprehensive parking surveys, and Woolwich's, look well ahead to future needs; but whether the provision of a single multi-storey garage, with some 500 car spaces, is consistent with the provision of escalators to deal with a possible influx into the Bull Ring centre of 28,000 shoppers an hour is doubtful.

For the most part, parking schemes are following the same pattern: meters for short-term and multi-storey garages for long-term parking. Regrettably too often the latter lags long behind the former, but Woolwich is a commendable exception since it is providing both at the same time. With the extension of meter schemes over wider areas, the provision of off-street facilities becomes more economic and a number of schemes are under way or projected. The process might be speeded up if meter charges were not subject to income tax and, more important, if meter charges were revised with a view to shortening the period for which they can be used. In London, two hours for a shilling, plus a third for ten shillings, is insufficient deterrent to long-term parkers, a regrettable number of whom move from space to space and engage in meter feeding. Greater flexibility is needed, with more severe restriction within city centres—where a maximum of an hour might be sufficient—but with longer periods on the periphery.

Public Transport

BUS operators have combined in a new organization—Britain's Buses—for the protection of that section of public transport which carries some 40 million passengers a day. It is claimed that the planners and unnecessary restrictions prevent the provision of fully efficient services at reasonable cost. With around 90 per cent of those travelling to work in urban areas still using public transport, the main objective is desirable, but it is necessary that the approach be positive and constructive and in accordance with modern needs. As it is, the initial campaign gives the impression of opposition to redevelopment plans in general, and to steps taken to improve traffic flow in particular, wherever they require readjustment of present services. Traffic engineering measures, from one-way streets to the banning of right-hand turns, inevitably require traffic rerouting, but there is no reason why the present pattern of services should be regarded as unalterable.

The traffic engineer's aim is to improve traffic flow, from which public transport is the first to benefit, as it permits greater regularity of services and more economic operation. On the other hand, there is little purpose in keeping traffic moving if it cannot set down and pick up its passengers and goods at the desired places. A fair balance, therefore, needs to be struck between maintaining traffic flow and the needs of public transport. For instance, if stopping places are too far removed from the busiest streets or main points of interchange, or if parallel one-way streets are too widely separated, considerable inconvenience may be caused. The requirements of public transport must be given full consideration, but no undue priority. Similarly, it is unreasonable to oppose the provision of adequate car parking facilities because they attract private transport, or the requirement that off-street bus stations be used in town centres, because passengers must then walk to the shops, provided both are suitably located. It is essential that all possible be done to preserve public transport and to prevent its deterioration to the point of extinction as has occurred in many American communities. This can be achieved with balanced planning for all forms of transport, public and private, rather than by restriction on either.

Road Research and Training

AT its open days last month, the Road Research Laboratory exhibited some of the unique work it is doing on road, traffic and safety research, reports of which appear regularly in this Journal. The new research track at Crowthorne is enabling much experimentation, and of particular interest was the work demonstrated in regard to the guidance and control of vehicle traffic; traffic density with a view to preventing congestion by conveying information as to the excessive volume of traffic to traffic lights and causing them to operate; and the experiments concerning the use of a computer to calculate the shortest route through a road network and to assign traffic thereto at times of congestion. Despite the excellent work done by the Laboratory, which a more generous allocation of public funds, more consistent with the present roads programme, would enable to be increased to advantage, the dissemination and application of its findings may not have been as widespread as it might be. One reason has been the shortage of fully qualified traffic engineers and their employment as yet by only a comparatively few local authorities. This is partly due to inadequate training facilities. A step towards meeting this deficiency was recently taken with the official opening of the new buildings and laboratories of the Graduate School of Highway and Traffic Engineering in the Civil Engineering Department at the University of Birmingham. These are fully equipped for classes and project work in all branches of highway construction and traffic engineering and mark the culmination of six years efforts firmly to establish this school and will permit the enrollment of 50 students during the coming academic year.

ENFIELD'S Town Centre Project

Fig. 1. Enfield Town Centre traffic-bound as it is today.

by H. D. PEAKE
M.Sc.(Eng), M.I.C.E., M.I.Mun.E., F.R.S.H., M.Inst.P.C.
Borough Engineer and Surveyor

A REPORT was recently submitted to the Enfield Borough Council describing the present parking and traffic problems in the Enfield Town Centre. These problems have arisen mainly from the great increase in the use of motor vehicles since the end of the war and particularly through the use of private cars for business and shopping purposes, and as a method of transportation between house and work. The report stated that it is in the Borough's interests that steps should be taken to ensure that all potential buyers can reach the shopping area as quickly as possible, leave their cars conveniently and cheaply, and return home with the minimum of inconvenience, failing which the traffic congestion and parking problems would reach such proportions that shoppers and trade would be driven to other places.

A plan (Fig. 3), included in the report, shows suggestions for the re-development of parts of the Town Centre and the conversion of all roads to pedestrian precincts to provide a pedestrian only shopping centre with flower beds, fountains and raised pavements to give the atmosphere of an inland spa, all within a circular one-way ring road providing for three lanes of traffic. This has been approved in principle by the Council as a basis for discussion in order to obtain the reactions of the public, business interests, amenity societies, ratepayers' associations, etc. The plan may be modified in the light of any advice and constructive criticism received. If this scheme, modified or otherwise, is eventually approved by the Enfield Council and is endorsed by the Middlesex County Council as the local planning authority, then it will be submitted to the Ministry of Housing and Local Government to whom the proposals must be justified.

The plan, although it indicates the positions of service roads, car parks and additional open spaces in and adjoining the Town Centre, is purely diagrammatic and indeed the service roads have been shown all one width and with right-angled junctions to stress this point.

As a preliminary to the preparation of the plan a survey of all properties in the Town Centre had to be carried out in order to establish their boundaries and the total amount of building accommodation now in use. This necessitated assistants visiting all premises to obtain details of residential accommodation, trade and shopping frontages, floor space occupied for each use, site area, open area, unloading and parking facilities, number of employees, and those using cars, manner in which vehicular access to the premises is obtained, other uses attached to premises, age and structural condition, etc.

In addition to volumetric and origin and destination traffic surveys, car parking surveys, and pedestrian surveys, which have provided valuable information regarding the daily movement of vehicles and people in and about the Town Centre, the extent of

delivery and collection of goods, are under close examination.

The analysis of the enormous amount of information which had to be gleaned is a guide to the way Enfield Town is likely to take shape in the future, and allowance will be made for flexibility in design because multiple and departmental stores, individual traders and others require different frontages and shopping depths.

The plan propounds two principles:

(*a*) A suggested solution to the problem of the moving and stationary vehicles in the Town Centre.
(*b*) The establishment of a pedestrian and shopping precinct where shoppers can wander from one side of the road to the other in pleasant surroundings and in perfect safety; where adults and children can cross roads to reach places of worship, library, public buildings and schools without conflict with heavy traffic flows.

To meet the requirements of the moving vehicle the following are considered necessary:

(*a*) A by-pass road to keep all main road through traffic clear of The Town—an outer circle encompassing the Borough, possibly being the best kind of by-pass.
(*b*) An inner ring road within the confines of The Town itself to allow the Town's own traffic to by-pass the centre as much as possible.

The D-Ring Road, which will be located along Enfield's north boundary, and is to be a trunk road connecting the Barnet By-Pass (A1) with the proposed Norwich—Docks Relief Road, should take a large part of the heavy commercial vehicles and cross-county traffic, leaving the proposed inner ring road to deal with the remainder.

Parking Survey

The nature and extent of the parking problem was determined by recording at frequent intervals the registration number of each vehicle parked on each street; information was also obtained about the parking times of vehicles in public and private car parks, and of the maximum number of vehicles waiting to load or unload goods at any one time.

One survey was carried out during the week Monday to Saturday, December 14-19, 1959, from 9 a.m. to 5.30 p.m. A further survey was carried out at half-hourly intervals in May 1960 to ascertain any variation in the volume and length of parking between winter and spring. It was noted that a variation of up to 20 per cent in parking can occur on the same day of different weeks under wet and dry conditions. From the information obtained the concentration of parked vehicles in different parts of the area at various times of the day, the number of long-term parkers, shoppers and other short-term visitors etc., was determined. All vehicles, with the exception of solo motor-cycles and public service vehicles, were included in the parked traffic counts, and records of all commercial vehicles were made in order that a separate analysis of vehicle types would be possible.

Street car parking capacity was next determined and a plan prepared showing existing parking restrictions, the proposed street parking places (divided off to show individual parking bays with gaps for loading and unloading of vehicles), lengths where parking of any kind should be prohibited, pedestrian crossings, location of traffic signals, and sites suggested for public car parks.

Fig. 2. Town Centre traffic free pedestrian precinct as planned.

The proposal to prohibit parking in narrow streets and near road-junctions, and the provision in the scheme for proper facilities for loading and unloading, resulted in an estimated capacity for the parking of substantially fewer cars than are commonly parked in the area at the present time. This was to be expected because in Enfield Town difficulties now arise as a result of uncontrolled parking and the loading and unloading of goods when vehicles are parked continually both sides of the street; this often results in double-banking and obstruction of through traffic. It is anticipated that once the parking scheme is in operation many of these difficulties will be largely eliminated. A comparison of the parking spaces to be made available under the scheme, with the parking requirements found by the survey, enabled an estimate to be made of immediate and future needs by way of ground, multi-storey and roof parking spaces.

Traffic Flow Data

Before the road proposals could be formulated, it was necessary to obtain basic data on traffic flows, etc., both vehicular and pedestrian, and traffic surveys were carried out in April and May 1960 to ascertain the volume, direction, type and characteristics of traffic proceeding along the main routes terminating or passing within one mile of The Town. The April survey was primarily a volumetric one, to ascertain the number of vehicles of various types passing the census points in both directions between 8 a.m. and 6.15 p.m., whereas the purpose of the May survey was to determine also the proportion which could be diverted from the Town Centre.

To avoid serious congestion, which would have been caused by stopping all vehicles to question drivers, a typical cross-section of the flow was stopped from time to time: the total vehicles stopped amounting to 40 per cent of the flow, and drivers were asked the starting point of their journeys and their destination. A volumetric census was also taken at the same time.

It was fortunate that the Middlesex County Council had carried out parking surveys in the Enfield Town Centre in November 1955 and February 1956; and a comparison with the present census figures revealed that the number of short-period parkers had increased by 45 per cent and all-day parkers by the surprising figure of 150 per cent in just over four years. The total number of parked vehicles recorded had increased by 64 per cent in the same period.

Various summaries giving the following information were prepared:

(1) The numbers of times the same vehicles were found parked in the streets as against the numbers of vehicles parked at the various census times.

(2) The total number of different vehicles parked in and adjoining the Town Centre on each day of the week.

(3) The percentage of short-period to long-term parkers and the number and percentage of long-term parkers each day of the week.

(4) The maximum number of different vehicles parked each day of the week and the officially approved parking provision as a percentage of the maximum number of vehicles parked. This indicates the inadequacy of the existing parking arrangements.

(5) The daily average number of vehicles parked and percentage increases of maximum daily parking over weekly average.

(6) An estimate of the number of shoppers and trades people, other visitors and long-term parkers parking each day of the week. Deducting the figure for average parking during Wednesday afternoons (early closing day) from the figures for maximum parking provides an indication of the number of shoppers and trades people using cars who are attracted to the Enfield Town Centre on each shopping day of the week.

(7) Long-term parkers as a percentage of the average number parking each day. This revealed that the percentage of long-term parkers approximates to 74 whereas on Saturdays, as would be expected, the figure drops to 40 per cent.

(8) An analysis of the total number of long-term parkers throughout the week. These figures provided details of the vehicles being left on the streets.

(9) A comparison of shopping and commercial frontage with the number of cars parked.

It is of interest that the number of cars now parked per 100 ft. of shopping and commercial frontage on week-days is approximately 11, and 15.6 on Saturdays as compared with 6.2 estimated for week-days on the basis of a survey carried out by the Middlesex County Council in April 1958. This indicates the extremely rapid growth in parking during the past two years.

The total kerb lengths occupied by vehicles was found to be 28,050 ft. Allowing for present and suggested restrictions, such as No Waiting Orders, bus stops, vehicular entrances etc., the reasonable available street parking length is 12,850 ft. The

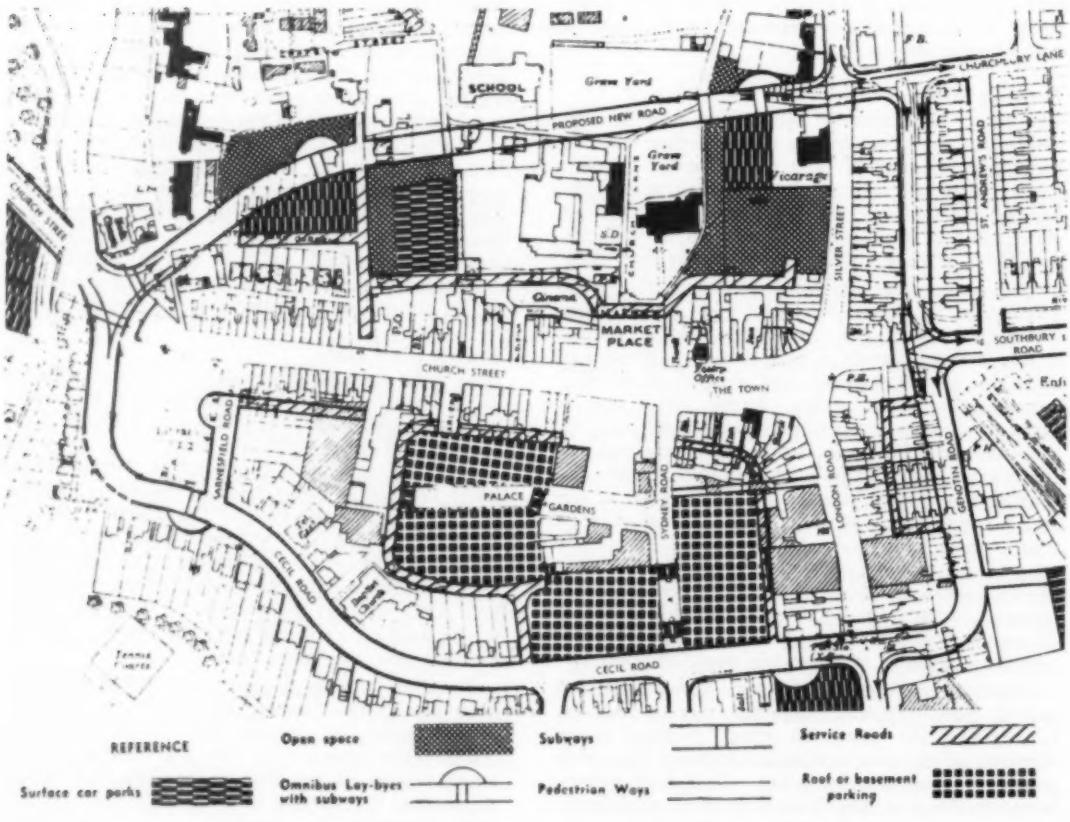

Fig. 3. Map showing planned pedestrian precinct and proposed car parking facilities.

maximum number of vehicles counted during the December survey was 1,160, whereas it is considered that on the basis of the reasonable parking length of 12,850 ft. given above only 672 vehicles should be parked in and adjoining the shopping centre.

Taking a two-hour period on Saturdays as short-term parking, an analysis of the 1,160 parkers showed 1,020 were short-term parkers and 140 long-term. An additional 10 per cent was added to cover turnover allowances, giving 1,122 and 154 spaces required for short- and long-term parkers respectively. In other words, as parking spaces can properly be made available at present for only 672 cars there is an additional car parking requirement for 600 cars.

Shopping Frontage

It is estimated there is every likelihood of a shopping frontage of 2,100 ft. being built within three years additional to the present shopping frontage of 6,100 ft. Taking the peak figures, and allowing for the need generated by the additional shopping frontage, space for 1,495 and 205 short- and long-term parkers will be needed in three years, not allowing for the anticipated increase in vehicle registrations. Against this there will be a reduction from 672 to 632 in the spaces at present available when new shopping frontages are developed. To meet the demand, in three years' time, additional parking will be required for at least 1,070 cars.

The Report of the Road Research Board 1959 forecasts a 100 per cent increase in ten years and the demand on this basis for parking places will be for 3,000 short-term parkers and 400-500 long-term parkers (the latter figure rising considerably during mid-week) in ten years' time.

The plan in Fig. 3 shows suggested new parking provision for Enfield Town Centre by way of surface and multi-storey car parks, and roof or basement car parking in new development; this would provide for 2,370 car spaces dispersed throughout the Centre and closely adjoining the inner ring road.

The analysis sheets for the traffic censuses of April and May reveal that during morning peak traffic flows, only about 34 per cent of vehicles will stop in or around Enfield either temporarily or for a longer period.

Pedestrian Precinct

The report to the Council stresses that the core of the proposals for the Supplementary Town Map, covering 117 acres, is the establishment of a pedestrian shopping precinct 37½ acres in extent and served by a tightly circulating inner ring road designed to separate the three miles an hour pedestrian from the 30 miles an hour vehicle.

Further points from the report follow:

(1) No pedestrian movement will be allowed across the inner ring road, and indeed no footpath is required or proposed along the northern side of its north leg. Pedestrians will reach the Town Centre by the many subways to be provided beneath the ring road.

(2) Provision for two carriage lanes only on the inner ring road is made until a third lane is warranted by future increased traffic flows. Even if the main routes entering the Town Centre were doubled in traffic capacity the inner ring road, with its eventual three one-way traffic lanes, totalling six traffic lanes, round the Town Centre, would be adequate.

(3) All subways will be provided with ramps, and levels in many places may allow the raising of the inner ring road by 3 ft.-4 ft., e.g. between Gentleman's Row and Little Park Gardens—where the existing footpaths to roads outside the circulatory route will gradually dip down under them, so that pedestrians can enter the pedestrian precinct in safety. Subways could be lined with white mosaic and concealed lighting to make them more attractive.

(4) The inner ring road would have a length of 1,610 yd. including Cecil Road, 630 yd. long, and necessitates the demolition of only 13 houses, all of which were built before 1914, and 25 other houses, built before 1866 or 1896, which have either been condemned as unfit or ripe for redevelopment. In addition, some 18 shops and/or offices would be affected, but the proposals for the Town Centre provide for a minimum of 2,000 ft. additional shopping and office frontage.

(5) The pleasant open character of Enfield Town will not only be preserved but enhanced by provision of additional parks. One on the west side of Silver Street will allow pedestrians to meander from this shopping precinct into the Market Place. (This park will incorporate the disused burial ground which the Council has already resolved shall be converted to a garden).

(6) The possibility of providing outdoor art and other exhibitions under attractive awnings as an additional feature of the shopping precinct is to be considered.

(7) Provision for escalators in shops in certain parts of the precinct will allow for two-storey shopping in conjunction with footpaths at first floor level.

Existing traffic conditions in the Town Centre are shown in Fig. 1, and Fig. 2 is an artist's sketch of the same scene laid out in a new and much more pleasant way.

It is the intention of the Council, with the help of the people of Enfield, not only to preserve the special features of Enfield, such as Gentleman's Row, New River Gardens, etc., but to ensure the development of the business and shopping centre in such a way as to create a future town which will be the pride of the Enfield citizens in the years to come, and the envy of other boroughs.

JULY ISSUE

WREXHAM'S O AND D SURVEY

D. M. Craig
Former Chief Engineering Assistant
Borough of Wrexham

HIGHWAY PLANNING STUDY, VANCOUVER, B.C.

Peter Long
City Engineering Department
Vancouver

TRAFFIC VOLUMES, TIMES AND SPEEDS BY MOVING-OBSERVER METHOD

T. E. H. Williams and J. Emmerson
Department of Civil Engineering
King's College, Newcastle upon Tyne

TRAFFIC CONTROL DEVICE MANUAL (2) SIGNALS AND CHANNELIZATION

William L. Carson and Burton W. Marsh
American Automobile Association

LIGHTING AND ROAD SAFETY

F. Bahler
Engineer, Forces Motrices
Bernoises

Road User Behaviour at a Pedestrian Crossing

by S. J. Older, B.Sc. and Julia M. Basden

Road Research Laboratory

THE pedestrian crossing at Crouch End Broadway, Hornsey, has been the subject of observations on pedestrian and driver behaviour since 1948. Every year, with the exception of 1956, a team from the Road Research Laboratory has visited the crossing at about the same time of year and counts have been made of the number of pedestrians on or within 20 yards of the crossing and of the vehicle flow. From these observations two measures of road user behaviour, a Behaviour Index for pedestrians and a Courtesy Index for drivers, have been calculated.

Factors Affecting Observations

A pedestrian crossing was established at this site in November 1935 and in February 1948 it was given a zebra marking with 1 ft. wide stripes as part of the research programme of the Road Research Laboratory. Another factor of importance at this time was that from October 1947 there was no petrol available for private motorists until June 1, 1948, when the basic petrol ration was re-introduced and this continued until May 1950. This resulted in a steady increase in traffic as shown in Fig. 5. In 1949 a National Pedestrian Crossing week was held from April 3 to 9 and, although this was too late to influence the 1949 observations, it may have contributed to the continued improvement in behaviour observed in 1950.

At the time of the observations in 1951 (Table I) the crossing stripes were worn and almost obliterated, but, following the new pedestrian crossing regulations, the crossing was re-striped with the standard 2 ft. wide stripes in October 1951. The new regulations specified the marking of the crossings and also established the precedence of pedestrians over vehicles at uncontrolled crossings and made provision for restrictions on certain vehicles parking in the vicinity of an uncontrolled crossing. Various states of the striping, between 1948 and 1952, are shown in Figs. 1-4.

The crossing was again marked in September 1953 after the carriageway at Crouch End Broadway was resurfaced. In February 1954, flashing beacons were installed and this factor, plus any publicity the installations might have had, may have influenced the Behaviour Indices in continuing the upward trend since the observations were carried out in March, a

Fig. 1. The crossing before striping in 1948.

Fig. 2. Worn 1 ft. stripes in 1950.

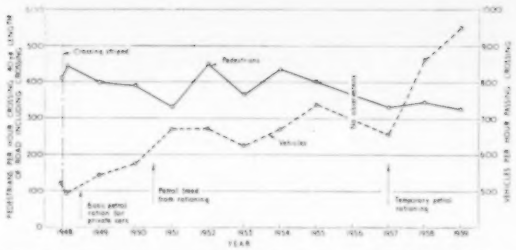

Fig. 5. Pedestrian and vehicle flows in the vicinity of the pedestrian crossing, 1948-1959.

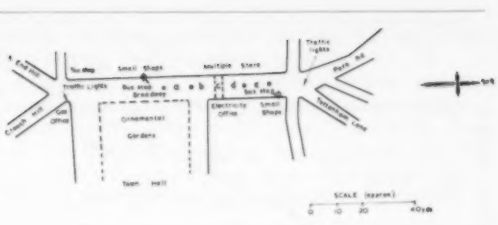

Fig. 6. Site of pedestrian crossing, Crouch End Broadway. Not true to scale.

month after the beacons' installation. Also in 1954, it became an offence for any vehicle to park within 45 ft. of any zebra crossing on the approach side. In December 1954, the crossing was re-striped with an experimental material of rubberized macadam.

In February 1955, the number of London Transport Executive buses was reduced by five per cent because there were fewer passengers, but no obvious effect of this is seen in the results for 1955. In September 1956, the crossing was again re-striped. In December, petrol rationing was re-introduced owing to the Suez crisis and continued until May 15, 1957. The observations made in 1957 showed that this rationing had a marked effect on traffic flow. The crossing was again re-striped in September 1958.

The changes in total vehicle and pedestrian flows are shown in Fig. 5. The dates and times of the observations are given in Table I: in 1952, 1953 and 1954, only one half of the normal observations were made.

TABLE I
Dates of observations from 1948 *to* 1959

	Tuesday	Friday
Before zebra marking	10/2/48	11/2/48 (Wed.)
1 week after zebra marking	17/2/48	20/2/48
1 year after	22/2/49	25/2/49
2 years after	28/2/50	3/3/50
3 years after	13/3/51	16/3/51
4 years after		25/1/52
5 years after		6/2/53
6 years after		19/3/54
7 years after		18/3/55 \ 1/4/55 /
8 years after	No observations	
9 years after	26/3/57	29/3/57
10 years after	1/4/58	28/3/58
11 years after	17/3/59	20/3/59

On each day the observations were made from 11 *a.m. to* 12.30 *p.m. and from* 1.30 *p.m. to* 3.30 *p.m.*

Method of Observation

The area of observation consisted of two 10-yard sections on each side of the crossing, and the crossing itself. These are known as sections a, b, c, d, and e. (Fig. 6.) Observer one counted all the pedestrians crossing in sections a or b and also the north-bound traffic. Observer two counted all the people using the crossing and also vehicles giving way to pedestrians in the two streams of traffic. Observer three counted all pedestrians crossing in sections d and e and the south-bound traffic. Pedestrians were counted and classified as they crossed the crown of the road. Children under school-leaving age were not counted. A vehicle giving way was defined as a vehicle which stops or slows down to allow a pedestrian to cross the road. Only the first vehicle in a queue of vehicles giving way was counted. The data were recorded for each quarter-hour during the period of observations. The number of pedestrians on the crossing expressed as a percentage of the total pedestrian flow in the whole section is here called the pedestrian Behaviour Index, and the percentage of vehicles giving way out of those which might be expected to give way is defined as the Courtesy Index for Drivers.

Results

The average values for each set of observations are given in Table II. The pedestrian Behaviour Indices have been adjusted for the same levels of vehicle flow in each year. This was done because there was a relation between the Behaviour Indices and the level

Fig. 3. 1951 after further wear.

Fig. 4. Standard 2 ft. stripes, 1952 and subsequent years.

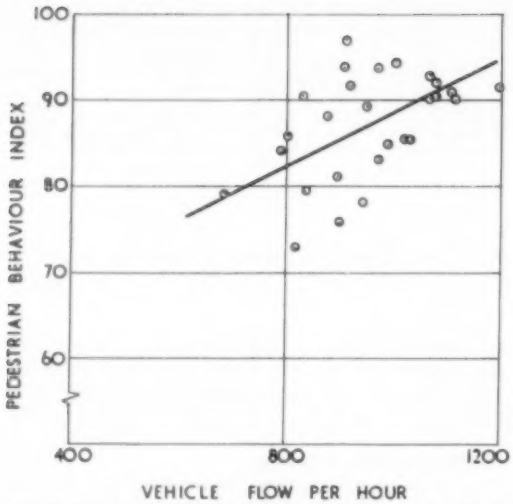

Fig. 7. Regression of women's Behaviour Index and vehicle flow 1959.

of vehicle flow in each year's results. A flow level of 670 vehicles per hour was taken to avoid predictions from the ends of the fitted lines of the within-year relation, an example of which is given in Fig. 7.

It will be seen from Table II and Fig. 8 that there was a steady rise in the Behaviour Index of both men and women from 1948 to 1954 but since that time a slight falling off is apparent. Low values in 1951 could be due to the poor state of the crossing in that year. A particularly large increase occurred between 1951 and 1952 during which time the pedestrian crossing regulations were changed and zebra marking

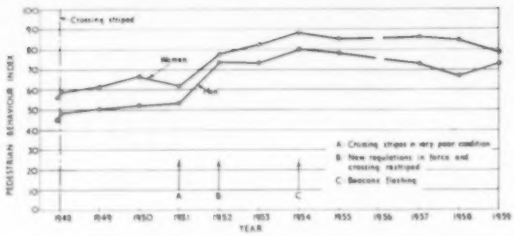

Fig. 8. Pedestrian behaviour indices for crossing at Crouch End Broadway, 1948-1959. *For constant level of vehicle flow.*

was generally introduced throughout the country. The behaviour of women has been consistently better than that of men over the whole period although both change in a similar manner.

Driver behaviour has proved more difficult to assess in that it was not found practicable to ask the observers to assess the conditions in which a vehicle should give way. It has, however, been possible, by making certain assumptions regarding the arrival times of pedestrians and vehicles and the average time a pedestrian takes in traversing the crossing, to estimate an expected number of vehicles that should give way. The assumptions necessary are as follows:

(1) Pedestrians arrive at random at an average rate of p per second and vehicles arrive at random and independently of pedestrians at a rate of q per second from each direction.
(2) A vehicle giving way to a pedestrian does not affect the arrival of other vehicles.
(3) A vehicle should give way if it arrives within six seconds of a pedestrian starting to cross the road and is not preceded by another vehicle in the same direction in that time.
(Six seconds being the average time for a pedestrian to cross the road.)

TABLE II
Average values for each year of observations

Year	Period of observations	Average vehicles per hour	Average no. of pedestrians per hour on and within 20 yd. of the crossing		Average no. of pedestrians per hour on crossing		Pedestrian Behaviour Index (Corrected)*		Courtesy Index
			Men	Women	Men	Women	Men	Women	
1948 (Before marking)	8 hours	520	97	313	28	137	45.1	55.9	12.1
1948 (After marking)	6 hours	492	79	267	29	138	48.5	58.1	12.1
1949	6 hours	543	100	299	46	182	50.2	60.8	17.1
1950	6 hours	575	94	295	43	181	52.0	66.6	26.4
1951	9¾ hours	668	75	257	41	167	53.1	61.4	22.3
1952	3¼ hours	670	98	350	71	278	73.6	77.8	37.0
1953	3¼ hours	623	90	276	65	229	72.9	82.3	22.3
1954	3¼ hours	667	111	323	89	285	79.7	88.1	27.0
1955	6½ hours	738	106	295	82	257	77.9	85.0	34.7
1956	—	—	—	—	—	—	—	—	—
1957	6½ hours	654	79	253	56	218	72.4	86.0	26.0
1958	6½ hours	862	80	265	56	231	66.2	79.3	26.6
1959	6½ hours	949	77	249	58	218	72.9	78.4	25.7

*Corrected for a level of 670 vehicles per hour.

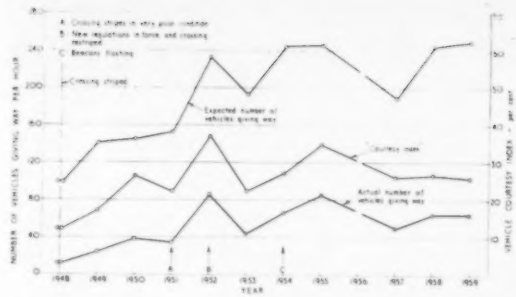

Fig. 9. Actual and expected number of vehicles giving way to pedestrians and the Courtesy Index for crossing at Crouch End Broadway, 1948-1959.

Owing to the presence of traffic lights in the vicinity, it is likely that the arrival times of vehicles depart slightly from a random sequence. Further, pedestrians sometimes arrive in groups and thus will not be strictly random. On these assumptions, a given vehicle should give way to a pedestrian if both the following occur:

(i) in the preceding six seconds at least one pedestrian or vehicle in the same direction arrives; the probability of this is

$$\left\{1 - e^{-6(p+q)}\right\}$$

(ii) the last of these one or more arrivals is a pedestrian, this has the probability:

$$\frac{p}{p+q}$$

The probability, P_s, that the vehicle should give way is therefore given by the equation

$$P_s = \frac{p}{p+q}\left\{1 - e^{-6(p+q)}\right\}$$

The expected number of vehicles giving way in one direction in a period in which Q vehicles in all pass the crossing is

$$E_s = Q \cdot P_s$$

The total expected number of vehicles giving way at the crossing is then the sum of the two values of E for the two directions.

Courtesy Index

It is thought that, from the assumptions made, this method overestimates the vehicles that might be expected to give way under a reasonable interpretation of the crossing regulations but that it is still valid in showing the relative change from year to year. The validity is borne out by the fact that, when plotted, the yearly values of the expected number of vehicles giving way follow very closely the curve of the actual number of vehicles giving way (Fig. 9).

Also in Fig. 9 a Courtesy Index is shown, calculated as:

$$\frac{\text{Actual vehicles giving way}}{\text{Expected vehicles giving way}} \times 100$$

This index was highest in 1952, immediately after the change in regulations. Since then the driver behaviour has worsened slightly but it is still more than twice as good as it was before striping.

As seen from Fig. 5, the pedestrian flow over the section of road containing the crossing has remained almost constant over the 11 years. The vehicle flow over the crossing, however, has increased rapidly since 1955, the drop occurring in 1957 being due to the temporary introduction of petrol rationing.

There are signs of a tendency for the behaviour of road users at this zebra crossing to worsen slowly after reaching a peak level of courtesy between 1952 and 1954.

Pedestrian use of the crossing, however, is still at a high level and it may be that pedestrian behaviour is settling down to a constant level after the initial improvement due to the introduction of the new striped crossings.

Driver behaviour shows a long term improvement from 1948 to 1955 on which a sharp but temporary increase is superimposed in 1952, immediately after the introduction of the new crossings. After 1955 driver behaviour has worsened slightly but may be settling to a constant level.

Conclusions

Pedestrian use of the crossing shows a fairly steady improvement between 1948 and 1954 with a marked rise in 1952 following the general introduction of zebra marking for pedestrian crossings. Since 1954, when over 80 per cent of pedestrians in the vicinity used the crossing, there has been a slight decrease in the use of the crossing by both men and women although more than 70 per cent are still using it.

Driver behaviour reached its peak in 1952 with a courtesy index of 37 per cent. Since then the index has declined to the present level of 26 per cent, which is still more than twice the original behaviour level.

Acknowledgments

The co-operation of the Borough Engineer and Surveyor of Hornsey in providing a detailed history of the crossing, and in helping with observation arrangements, is gratefully acknowledged.

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NEXT MONTH'S
ROAD RESEARCH REPORT

USE OF REFLECTORS ON RAISED KERBS

by A. W. Christie, M.A., B.SC., Road Research Laboratory

American Report

TRAFFIC CONTROL DEVICES MANUAL

Fig. 1. Overhead direction signs in New York City, incorporating route numbers.

I - Signs and Markings

by

Burton W. Marsh and William L. Carson
American Automobile Association

IMPROVEMENTS in the more uniform application and usage of traffic control devices in the United States shortly will gain considerable impetus with the publication of a new edition of the national Manual on Uniform Traffic Control Devices for Streets and Highways. The 1961 edition will include many important changes in, and additions to, the previous Manual as published in 1948. It will be a valuable incentive and guide to states and communities desiring to improve the quality, effectiveness, and uniformity of their traffic signs, signals and markings. The importance of such a manual in the United States—with our large inter-state traffic—will be better understood when it is realized that not only does each of our 50 states have independent authority over the great majority of its traffic control devices, but also in most states each county and each municipality has a large degree of autonomy thereover.

By law, traffic signs, signals and markings used on federal aid system highways (roads for which the Federal Government has paid part of the construction cost) are subject to approval of the state highway department with the concurrence of the U.S. Secretary of Commerce. In recognition of the importance of the Manual's provisions and of the need for achieving uniformity in traffic control device usage, the Commerce Department's Bureau of Public Roads has announced that it will approve for installation on federal aid roads only such traffic control devices as conform to the new Manual. Reasonable time will be allowed for jurisdictions to replace existing devices that are inconsistent with Manual standards. While a normal service life will generally be allowed, to further expedite conformance with the Manual, the Bureau will approve a State's use of their federal aid allocations for sign modernization on a state-wide or selected system basis.

Numerous groups and individuals in the United States have long recognized the importance of uniform design and application standards for traffic

control devices. Over the past 40 years, a number of guides to help effect such uniformity have been issued, including a manual for rural highway signs published in 1927 by the American Association of State Highway Officials and one for signs, signals and markings on urban streets published in 1929 by the National Conference on Street and Highway Safety. The initial national Manual, covering both urban and rural facilities, was developed by a joint committee of these two groups in 1935.

Compilation by Committee

The new Manual has been developed by the 25-member National Joint Committee on Uniform Traffic Control Devices, which is now composed of representatives of the American Association of State Highway Officials, National Committee on Uniform Traffic Laws and Ordinances, Institute of Traffic Engineers, American Municipal Association, and National Association of County Officials. Each of the first three organizations has seven representatives on the committee while the latter two organizations, which joined the committee in 1960, have two representatives each. Members from the National Committee on Uniform Traffic Laws and Ordinances are mainly representatives of non-official organizations, but all other persons serving on the joint committee are public officials. Because of their direct commercial interest in certain decisions which are made by the committee, manufacturers of traffic control devices do not have representatives on the joint committee. However, through an advisory committee, close liaison is maintained between the Joint Committee and manufacturers, who provide valuable information and counsel. Secretarial and publishing services for the joint committee are provided by the U.S. Bureau of Public Roads.

A number of sub-committees were appointed to prepare proposed revisions. These sub-committees included many individuals who are not members of the joint committee. In addition to providing greater geographical representation, this made it possible to secure the assistance of additional persons who are particularly knowledgeable on various subjects covered in the Manual.

Use of Manual

Previous editions of the Manual have proved valuable in effecting improved uniformity and generally better traffic control. While responsibility and authority for the design, installation, operation and maintenance of such devices varies considerably from one place to another, most states, and an increasing proportion of local communities, now follow the principles and standards set forth in the national Manual. In some States, laws require that the devices used on state roads conform to those set forth in the national Manual, while in other States, a state manual conforming closely to the Manual must be followed. The value of the national Manual to traffic authorities in urban areas has been increased by giving wider and more specific coverage to the needs of city traffic in the 1961 edition. The likelihood of securing greatly increased local adoption has been helped tremendously by addition of representatives of the American Municipal Association and the National Association of County Officials to the Joint Committee.

Fig. 2. Route number markers, the top sign gives the Federal Highway number and the lower the one for the State of Kansas.

Scope and Features of Manual

The Manual sets forth principles and standards for the design and application of traffic control signs, signals, markings and islands. The 1961 edition includes new sections on the use of these devices at locations of highway construction and maintenance, and as to civil defence signs. For the first time, the Manual also presents special standards for expressway (motorway) signing.

In the Manual's introduction, it is noted that traffic control devices should:

1. Be capable of fulfilling an important need.
2. Command attention.
3. Convey a clear, simple meaning.
4. Command respect of road users.
5. Be located so as to allow adequate time for response.

Additionally, those devices which control or regulate traffic must be sanctioned by law. The Manual cites four basic considerations that are involved in meeting the above requirements—design, placement, maintenance and uniformity.

Engineering Principles

True uniformity in traffic direction and control involves not only the use of standard devices, but also consistency in their manner of application at locations having similar conditions. The Manual stresses the need for basing the installation of traffic control devices on engineering studies and states that

> While this Manual describes the application of the various devices, it is not intended as a substitute for engineering judgment. Nor is it intended to discourage the imaginative application of the standards and principles which the Manual prescribes.

On this point, the Joint Committee makes provision for rigidly restricted recognition of proposals for experiment or research which it believes may hold promise for advances in this ever-developing field.

In those communities and jurisdictions which do not have qualified engineers on their staff, the Manual urges that assistance on major traffic control problems

be obtained from the state highway department or from other qualified outside agencies or individuals. However, local authorities will find the Manual to be an adequate guide for many of their day-to-day problems involving the use of traffic control devices. The Manual is intended to promote only the use of *warranted* traffic control devices. Hence in some instances, the proper use of the Manual may result in fewer but more effective devices.

In addition to changes that reflect increased experience and recent research, the new Manual includes a number of devices not covered in previous editions. To the extent considered practicable, this Manual eliminates alternatives in traffic control device design and usage. While previous Manuals presented specifications for sign materials and fabrication, pavement marking paint, and signal lens colours, such matters are not included in the 1961 edition—the belief of the Joint Committee being that these matters are more appropriately presented in other documents. As in previous editions, the 1961 Manual will contain numerous illustrations to supplement and clarify matters covered in the text.

Value of Manual

While a number of the traffic control devices used in the United States are inapplicable to other countries or are not employed there, it is felt that a report on basic provisions of the U.S. Manual will be of general interest to persons having traffic control responsibities anywhere. The authors also believe that other countries would derive considerable benefit from development of their own manuals, or inter-country manuals, on traffic control devices—as for instance, Canada has done recently. Experiences in the United States indicate that such a manual, adopted and followed by the various jurisdictions involved, can significantly improve the safety, efficiency, convenience and economy of traffic movement in both rural and urban areas.

The remainder of this article will be concerned with two of the U.S. Manual's basic sections—those on signs and markings. Part II of this report will appear in the July issue of *Traffic Engineering and Control* and will discuss the additional Manual subjects of Signals and Islands. Publication date of the new U.S. Manual is scheduled for the end of June but the price has not as yet been determined. Copies will be available from the U.S. Government Printing Office, Washington 25, D.C.

Signs

The Manual sets forth standards and criteria to be followed in the design, application and use of all types of traffic signs on U.S. streets and highways. They are placed in the three basic functional classifications of regulatory, warning, and guide signs. The standards are based primarily on the requirements of those highways and streets that constitute the basic road systems in the United States, but the Manual also recognizes the particular needs of expressways and the differences between rural and urban situations. Special expressway signs standards are presented in the Manual and, where appropriate, different specifications are set forth for rural and urban signs.

The Manual cites as basic requirements for any highway sign: (a) high visibility; (b) lettering or symbols of adequate size; (c) a short legend for quick comprehension. Standards are presented for the shapes, colours, dimensions, symbols, wording, lettering, and illumination or reflectorization of signs.

Regulatory Signs

Signs that are erected to inform highway users of traffic laws and regulations are classified as regulatory signs. Although the posting of all rules of the road is obviously neither feasible nor desirable, it is essential that regulatory signs clearly denoting the law involved be provided at locations where road users might otherwise be uninformed or uncertain as to the law's application and meaning.

Except for certain signs (mainly: Stop, Yield, and One Way signs), the U.S. Manual specifies that regulatory signs be rectangular in shape, present a black legend on a white background, and be posted with the longer sides vertical. Signs that are at least 30 in. by 36 in. may have white legend on a black background, however. The Manual further provides that, unless specifically excepted in the Manual, all regulatory signs are to be reflectorized or illuminated such that sign colours appear the same at night as during the day.

The Manual notes the importance of adequate enforcement in obtaining proper obedience to regulatory signs. It also cites the importance of removing signs when the regulations they convey are no longer applicable or effective.

Among the regulatory signs included in the Manual for the first time are lane-use control signs, employed at intersections to indicate the types of movement permissible or required for traffic in particular lanes. While the mounting of such signs directly above the traffic lanes to which they apply is preferred, provision is made for mounting them on posts at the roadside.

Warning Signs

Traffic signs that warn of existing or potentially hazardous conditions are classified as warning signs. They often require a specific action or manoeuvre on the part of drivers. The Manual notes the desirability of keeping the number of such signs to a minimum, since their excessive use or unnecessary application tends to lessen their impact and to create general disrespect for warning signs.

Manual standards specify that warning signs be at least 30 in. square, be posted with one diagonal vertical, present a black legend on a yellow background, and be reflectorized or illuminated when significant at night-time. The Manual stresses the importance of proper location of warning signs and advises that they should be placed approximately 750 ft. in advance of hazardous conditions in rural areas, while in urban areas, where vehicle speeds are comparatively low, a desirable distance is usually about 250 ft. The Manual also notes, however, that the advance mounting distance may need to be increased to 1,500 ft. or more on expressways and other high-speed roads.

As in previous editions, a number of the warning signs in the 1961 Manual present their message in symbols rather than words, including those signs

warning of road turns and intersections. For the first time, the Manual prescribes a symbol, rather than a word message, on signs warning the motorist of a coming reduction in the number of traffic lanes on his side of the road.

A limited number of warning signs do not follow the general specifications therefore. These include the Railroad Advance Warning Sign, a 36 in. diameter disc having a black 90° crossbuck X and black letters RR on a yellow background, the Railroad Crossbuck Sign, a white crossbuck with the words Railroad Crossing in black letters, and the Advisory Speed Plate, an 18 in. or 24 in. square plate with the advisory speed indicated in black on a yellow background. This plate is not intended to establish a legal speed limit and is to be used only in conjunction with warning signs posted below it.

Guide Signs

Classified as guide signs are those traffic signs which guide road users along officially established routes; provide direction and distance information as to destinations; identify rivers, parks, historical sites, etc.; and give other information that will make road travel expeditious, safe and pleasant. The 1961 edition of the U.S. Manual, as previous editions, sets forth specific standards for the design and use of all types of guide signs.

The Manual includes provisions for signs to be used on the National System of Interstate and Defence Highways. These are consistent with provisions of a special detailed manual, previously adopted by the American Association of State Highway Officials and approved by the U.S. Bureau of Public Roads, for signs and pavement markings on the Interstate System. The principles followed in the design and application of guide signs for modern expressways, including Interstate System roads, are essentially the same as those applied to guide signs for other highways. However, the nature of expressways and of the traffic they carry, require special sizes and types of signs, and these are specified in the new Manual. These signs take account of the high speeds and volumes of expressway traffic and of the need for giving expressway drivers information and guidance considerably in advance of points at which they will take responsive action.

The Manual notes that, unlike some types of traffic signs, standard guide signs do not lose their effectiveness when applied extensively. However, care should be taken to avoid presenting more information on any guide sign, or closely grouped signs, than can be quickly and easily comprehended by drivers.

Route Markers

U.S. route markers, as well as those for most state and local routes, have black legend on a white background, except that those on the National System of Interstate and Defence Highways are red, white and blue. The Manual establishes a standard, 16½ in. by 16 in., shield-shaped marker to be used for the some 800,000 miles of so-called United States (U.S.) Routes. In contrast, markers for routes known as state routes are designed by individual state highway departments. The Manual sets forth standards to be followed in the placing of route markers at and between intersections. Guides are also presented as to the design and use of junction signs,

Fig. 3. Junction assembly signs including the junction marker, directional arrow, and State route markers in Virginia.

cardinal direction markers, turn markers, and other auxiliary markers often used with route markers.

Provisions are also included for destination and distance signs. In rural areas, destination signs generally are to be located 200 to 300 ft. in advance of intersections, though in urban areas a shorter distance is often necessary or acceptable. Distance signs are horizontal rectangles showing the names of not more than three places and mileages to their centres. Standards and recommendations as to the lettering, location, and frequency of distance signs are given.

The Manual also covers street name, roadside rest area, motorist services, and parking area signs. Recommendations are made as to the use of mileposts to assist drivers and others in identifying their location, as in reporting on a breakdown.

Markings

Traffic markings have proved extremely valuable in effecting safe and efficient highway travel. Often at relatively little expenditure, they produce sizeable economic benefits through more orderly traffic movement and reduced accidents. While markings frequently are used in conjunction with traffic signs and signals, at times they alone serve an essential function. Pavement markings have a particular advantage in that they can indicate regulations or provide information without requiring drivers to take their eyes off the road. Uniformity in traffic markings is as important as for other traffic control devices, and this is emphasized in the new Manual.

In addition to pavement markings, the Manual classifies the following as markings: curb markings that indicate parking regulations; markings on objects within or adjacent to roadways; and reflector markers used on hazards or to delineate the roadway. Acceptable materials for pavement markings include paint, thermoplastic materials, and metal and plastic inserts and these are employed mainly in urban areas where paint markings usually have a relatively short

Concluded on page 103.

ACCIDENT FREQUENCY at SIGNAL-CONTROLLED CROSSROADS with an ALL-RED PERIOD

by R. F. Newby, B.Sc., F.S.S. *Road Research Laboratory*

THE Laboratory has previously shown that at a group of three-way or four-way junctions in the London area, which previously had Halt or Slow signs or no control at all, there was an overall reduction in accidents of about 40 per cent when traffic signals were installed. At crossroads only, the reduction was 30 per cent. In some circumstances traffic-signal engineers consider that an all-red period can be usefully added after each of the main red and green periods, and this article describes a study of the effect of this change on safety at such places. The all-red period, usually one or two seconds in length, helps to clear the intersection of turning vehicles, gives pedestrians a little extra time in which to cross, and lessens the risks arising from vehicles that attempt to cross during the amber or the beginning of the red periods.

Selected Sites

From records of traffic-light improvements supplied by the Ministry of Transport and the Metropolitan Police, twelve four-way junctions were selected in the Metropolitan Police District as being those at which an all-red period of one or two seconds had been added in recent years to the existing signal cycle without any other alterations in phasing or control. As far as could be ascertained, periods of two years before and after each change were free from other alterations. The number of injury accidents in these periods at the sample junctions could therefore be compared with trends in the vicinity. For this purpose, the total numbers of casualties during the same periods in the local authority area in which the junction was situated were used as the best available controls. Except for site 12, which is in Central London, the sample junctions were all in busy suburban streets.

Number of Injury Accidents

The number of injury accidents at each site in comparable periods of 24 months before and after the addition of the all-red period is classified into three types in Table I. The control ratio is the factor by which casualties in the after-period in the same local authority area exceeded those in the before-period. At the twelve sites combined, injury accidents in the after-periods were 41 per cent fewer than the number to be expected if the sample junctions had experienced the same trends as occurred in the control areas. The improvement was confined almost entirely to accidents involving two moving vehicles on different roads (type 1 in Table I), which were 83 per cent fewer than expected. Both these results are statistically highly significant. The changes in the frequency of accidents of Types 2 and 3 were not significant.

The number of accidents at individual sites was small, but a reduction in those involving two moving vehicles on different roads (the typical crossroad collision) was found at all but one site, indicating that the all-red period in the traffic signal cycle is effective in preventing crossroad accidents. At two sites (6 and 8) there were large reductions in accidents, but even if these two sites are omitted the combined changes at the other 10 sites remain highly significant.

TABLE I

Injury accidents at four-way traffic signals before and after the addition of an all-red period

Site No.	Accidents in two years before				Accidents in two years after				Control ratio
	Type 1	Type 2	Type 3	Total	Type 1	Type 2	Type 3	Total	
1	12	8	7	27	3*	4	13	20	1.26
2	2	0	2	4	0	0	9	9	1.17
3	5	5	8	18	0	3	11	14	1.04
4	5	2	13	20	1	2	11	14	1.08
5	7	2	8	17	1	6	9	16	1.03
6	6	0	6	12	0	1	2	3*	1.11
7	13	3	2	18	2*	5	6	13	1.03
8	10	6	8	24	0*	3	1*	4*	1.05
9	9	3	6	18	5	0	4	9	1.07
10	9	2	8	19	1*	0	10	11	1.11
11	0	0	3	3	0	1	2	3	0.99
12	1	2	5	8	2	2	2	6	1.13
TOTAL	79	33	76	188	15*	27	80	122*	1.10

*Significantly lower than the before value (P, the probability of obtaining by chance a reduction $\geqslant$ that observed, — 5 per cent or less).
Type 1: Two moving vehicles on different roads.
Type 2: One vehicle and pedestrian.
Type 3: Others.

It is possible that most of the reduction in accidents might have occurred soon after the all-red period had been added. To eliminate a novelty effect of this kind the accidents in the first six months of the after-period and the corresponding months of the before-period were omitted, producing for the group as a whole the results shown in Table II. These show almost the same benefit as those described above for the complete two-year periods and give no indication of the all-red having had a smaller effect after the initial six months. It is therefore concluded that the all-red period was effective in preventing crossroad collisions at those traffic signals where it was considered appropriate to add such a period.

TABLE II

Injury accidents at four-way traffic signals before and after the addition of an all-red period (omitting the first six months)

	Before	After	Percentage reduction compared with expected
Type 1	62	8	—88*
Type 2	22	21	—13
Type 3	61	64	— 3
TOTAL	145	93	—41*

Control ratio 1.08

*Reduction statistically significant (P — 5 per cent or less)

Acknowledgment

Thanks are due to the Commissioner of Police for the Metropolis for the traffic signal and accident data on which the investigation is based.

The work described in this article was carried out as part of the programme of the Road Research Board of the Department of Scientific and Industrial Research. The article is published by permission of the Director of Road Research.

American Report (*Concluded from page* 101)

life. Paint is normally used for object markings, often supplemented by reflecting buttons. Delineators and hazard markers consist of reflectors mounted singly or in clusters, or small reflectorized panels mounted on posts.

Use of Coloured Paints

The new Manual is explicit in its requirements as to the use of yellow and white colours in traffic markings. The Manual provides that when used only for guidance, and where their crossing by drivers is permissible, centre lines on two-lane rural roads and all lane lines are to be broken (dashed) lines. Guide lines which are not ordinarily to be crossed are to be solid white lines including centre lines on city streets, channelizing lines, pavement edge lines, and approach markings to obstructions which may be passed on either side. Lines to the left of which it is unsafe or illegal to drive are to be solid yellow.

Yellow is to be used for the double centre lines required on multi-laned pavements and which are not to be crossed, no-passing zone barrier line (the solid line on the driver's side—not the dashed line on the other side), curb parking prohibitions, kerb markings on islands in the line of traffic, certain hazard markers, and delineators at ramps and interchange areas. White is prescribed for centre lines of two-lane rural roads and city streets, lane lines, pavement edge lines, paved-shoulder markings, channelizing lines, turn markings, stop lines, crosswalk lines, parking stall limit lines, approaches to obstructions that may be passed on either side, and word and symbol pavement markings. The Manual provides that objects within or close to the roadway be marked with alternate black and white stripes or be painted white, with all white areas to be reflectorized. Pavement markings having application at night are also to be reflectorized.

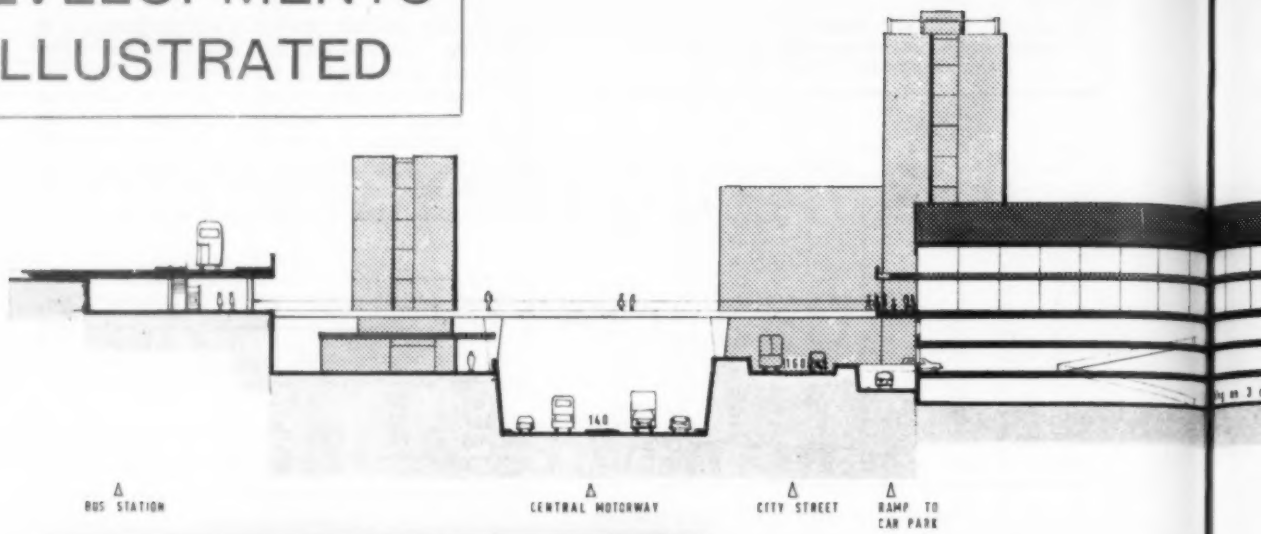
The Manual deals quite extensively with the marking of no-passing zones, an extremely important safety matter. In addition to prescribing the types of lines to be used, a solid yellow barrier line placed to the right of the centre or lane line, the Manual presents model state legislation taken from the Uniform Vehicle Code for the establishment of no-passing zones and sets forth warrants for their application based upon prevailing vehicle speeds and sight distances.

A new section in the Manual covers the use of pavement edge lines to discourage vehicle encroachment upon road shoulders, provide better guidance to drivers, and to reduce accidents. These 2 in. to 4 in. solid white lines supplement centre and lane lines and are never to be used as substitutes therefore. The Manual also discusses the treatment and marking of shoulder areas and the manner in which edge lines are thereby affected.

Signals and Islands

The new U.S. Manual on Uniform Traffic Control Devices also presents extensive material on the design and application of traffic control signals and on the various types of islands employed for safe vehicle and pedestrian movements. These will be discussed in Part II of this report, which will appear in the July issue of *Traffic Engineering and Control.*

DEVELOPMENTS ILLUSTRATED

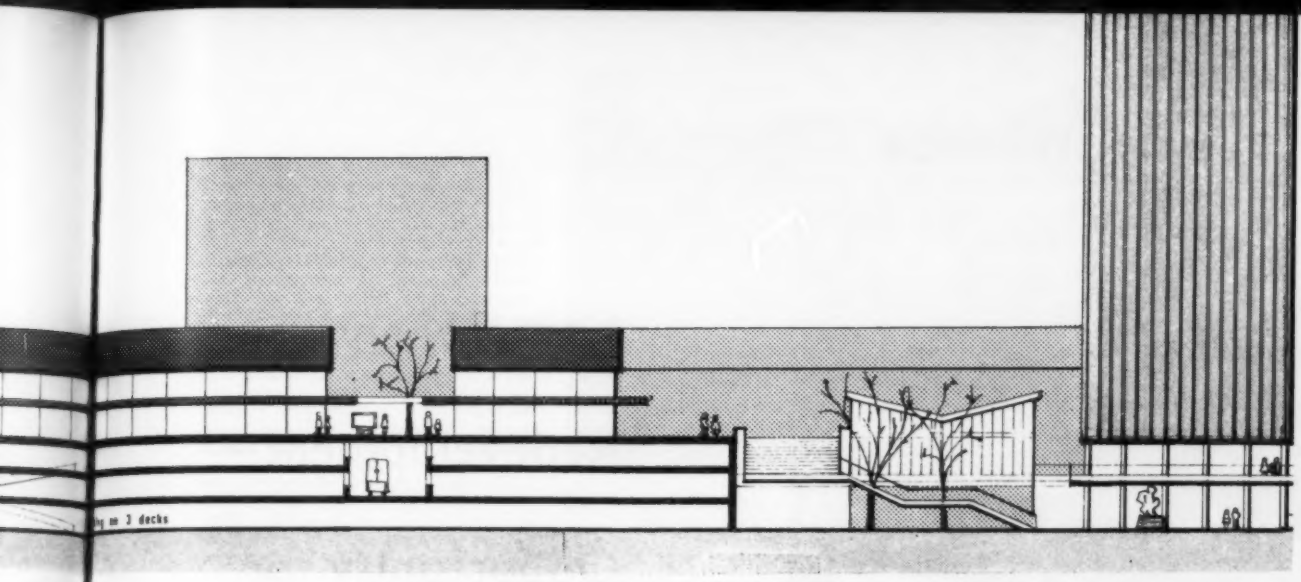


Part of the typical cross section of shopping area in the Ca... develop...

The redesigned Bull Ring area in Birmingham, showing the pedestrian precinct with the covered market in the centre. Photo: Laing Development Co., Ltd.

Apex Corner, at the southern end of the Barnet By-Pass before reconstruction.

Photograph: Aerofilms Ltd.



△
SHOPPING WAY
WITH SERVICE ACCESS BELOW

△
LANDSCAPED SQUARE WITH SCULPTURE

a in the Co[illegible]elopment, Newcastle upon Tyne, referred to on p. 117.

The model prepared by Laing Development Co. Ltd., on behalf of the Blackburn Corporation, of the proposed town centre which will form part of a comprehensive plan.

The new roundabout at Apex Corner, showing the dual carriageways to the north.

Fig. 1. Town Square at Stevenage, a good example of the horizontal shopping precinct.

Comprehensive Redevelopment—Opportunity for Traffic

by **C. D. BUCHANAN,**
B.Sc., A.R.I.B.A., A.M.I.C.E., M.T.P.I.

A Traffic Symposium, sponsored jointly by the Departments of Architecture, Town and Country Planning and Civil Engineering, King's College, University of Durham, and the Roads Campaign Council, was held at Newcastle upon Tyne, April 10 to 14. Extracts from the paper presented by Mr. C. D. Buchanan appear below.

THERE are several ways of approaching the traffic problem in towns other than literally in a motor car. Mine is the constructional approach. That is to say, when I observe a snarl up of traffic I instinctively ask what can be done by way of physical rearrangements to make things work better. Even within the constructional approach, however, there are various routes.

I dare say ninety-nine people out of a hundred would subscribe to the view that dealing with motor traffic in towns is primarily a matter of civil engineering, with which the more up-to-date among them might couple traffic engineering. My purpose in this paper is to apply a corrective to this popular view, to say that it is too narrow, and to submit that what we are really up against is a problem of architecture and that unless we realize this we run the risk of doing serious damage to our towns and cities. I hasten to make it clear that I am in no way trying to slight civil engineers, to run down traffic engineers, or to boost architects. All have vital parts to play in the vexing problems that confront us in urban areas consequent upon the growth of motor traffic, but I think it is absolutely essential to grasp the true nature of the problem and then to distinguish the various contributions that the professions can offer.

The notion that we are up against a primarily engineering problem is rooted in history. When motor vehicles first started moving about our roads the first problems they threw up were genuinely problems of engineering, and civil engineering at that. The very first thing to be tackled was the securing of all-weather surfaces. Then there was the question of dust. Then modest 'improvements' started—widening a road here, clipping off a corner there. Gradually the schemes increased in complexity, from bridge reconstructions and major realignments to the construction of completely new roads as in the Arterial Roads Programme after the first war. These schemes were executed by the local authorities with the aid of grants from the Road Fund, the latter being administered in the early days by the Road Board which became the Ministry of Transport in 1919.

When the Road Board first started work it decided that its funds, which were in a sense national moneys being the proceeds of the general taxes on vehicles and fuel, should be used only for national traffic, that is to say used only for schemes that would assist the flow of through traffic and not for local traffic. That principle has been adhered to to this day. If a local authority wanted a grant it had to prove that the scheme would benefit the flow of through traffic. In rural areas this was

fair enough, for it was mainly the inter-town flows that were concerned, but in urban areas it is my belief that over the years the system fostered an attitude of mind concerned exclusively with through or moving traffic and hence of the engineering problems of accommodating that traffic. This, I submit, has hindered understanding of what has really been happening in towns.

What has been happening can be seen by considering the case of the town that has been by-passed. Now I agree that when a tiny place such as Markyate Street on A5 is by-passed the relief is almost complete. But if you visit any genuine town, even quite a small one, which has been by-passed you will, as likely as not, find it chok-a-block with traffic. Of course, the situation would be worse without the by-pass, but the fact remains that whilst the classical engineering solution has been of benefit to the through traffic it has by no means solved the town's own problem of living with the motor vehicle. This problem arises from the fact that large numbers of people have been discovering the value of a most ingenious and versatile invention, and have been seeking to use it for a thousand-and-one everyday purposes. This has resulted in the invasion of urban areas by large numbers of vehicles bound on essentially local journeys to an extent that the street and building arrangements cannot stand. A transport, and to some extent a social revolution has been taking place before our very eyes, but by some mischance it has remained virtually undocumented. Even the many origin and destination surveys that have been made have been directed primarily to eliciting the amount and direction of through traffic with a view to deciding diversionary routes for that traffic, though often these surveys have been of value (sometimes to the perplexity of their originators) in showing the power of a town to induce traffic of itself, even if throwing little light on the detailed nature of the movements. This, I submit, is a serious gap in our knowledge at a critical time when we are coming face to face with the truth that motor traffic, for all its utility, is playing havoc with the basic civilized values of our towns, and threatening the continuance of our whole tradition of urban living.

Although this aspect of traffic has been sadly neglected it is not difficult to see the essential nature of the vehicular usage which people are now seeking. The apparently complex movements one observes in the streets are, virtually without exception for I am disregarding genuine through traffic, described by *vehicles in search of buildings*. Even the buses are no good unless they go near the buildings. The simpler the layout of the buildings (as in a straight village street) the simpler is the circulation pattern; the more complicated the arrangement of the buildings (as in the middle of a city) the more complex and intricate is the circulation. In the latter case, if you were to take a plan of the area, and draw upon it a series of straight point to point lines the result would be a dense criss-cross of lines over the whole area. In practice, of course, the journeys cannot be made in straight lines from point to point, the vehicles have to follow existing streets. Many vehicles in consequence find themselves sharing the same road, for greater or lesser distances, as they proceed on their individual journeys, and this is what conveys to the casual observer stationed at one point the impression of a throng of vehicles hurrying along as though all bound on the same long journey. In fact, the reality is much more complicated.

Of course there are certain roads in almost any town along which so many vehicles find a common path for so considerable a distance that they can almost be called through traffic routes. Along most radial roads, for instance, there seems to be a body of traffic from the outside world bound for the centre, traffic which for most of the length of the radial is through traffic in relation to the lateral development. This traffic, of course, is supplemented by other vehicles draining in from the built-up hinterland and by still other vehicles bound on local journeys. It is this mixture of traffic on the radial roads, coupled with the fact that they are also local development roads, usually with a scatter of shops throughout their length, that has created the terrible conditions that now obtain. In my view, our radial roads present one of the most formidable planning problems we have to face today.

My proposition is that in an urban area, if you disregard through traffic, the vehicular movements are wholly related to the buildings (and of course to activities, limited in number, which take place on open land without the presence of buildings in the accepted sense) and that it is ludicrous to try to keep the planning of the roads and the planning of the buildings in separate compartments. You might as well hand over the rooms of a house to one designer and the passages and staircases to another. Indeed I think there is a very close analogy here—I submit that there is no essential difference between planning the accommodation of a building, with all the circulation problems involved, and planning the accommodation of an urban area with all the circulation problems of vehicles and pedestrians. In both cases there is a design problem of disposing occupiable space in relation to means of access. So, if designing a house or a hospital be defined as a problem in architectural design, so, I submit, must designing an urban area be basically a problem in architectural design.

I would not, however, wish to convey the impression that I regard the design of an urban area as exclusively a job for the architectural profession. All I want to demonstrate is the absolute oneness of traffic planning and building planning and that in its essentials it is architectural design on a big scale, so big in fact that there is room and need for all the constructional professions to collaborate. I am encouraged in this

Concluded on page 127.

Fig. 2. Rear service area at Stevenage. The price paid for horizontal segregation: the precinct set in a dreary sea of car parks and goods rear access ways.

Fig. 3. The importance of local traffic revealed by new road on viaduct in Brussels constructed down the main boulevard with congestion below.

FUTURE DEVELOPMENTS IN TRAFFIC SIGNALS

by F. V. Webster, B.Sc., Ph.D.

Principal Scientific Officer, Traffic and Safety Division, Road Research Laboratory

Paper presented to the Institution of Civil Engineers Traffic Engineering Study Group March 16, 1961.

FUTURE developments in traffic signals may be divided into two categories—those which are already under development and those which, at the moment, can only be regarded as reasonable possibilities. In the first category most of the basic research has been done and there is a reasonable expectation that, apart from teething troubles, the systems should work. In the second category however, although much thought has already gone into some aspects of the schemes, there is no certainty that a scheme as a whole will be worthwhile in the practical sense. Much more research will have to be done to determine this and, if the results appear promising, to devise suitable practical schemes. The following is a selection of some of the possible developments which may take place in the field of traffic signals in the near future.

Increased Vehicle-Actuation

Traffic control systems continue to become more flexible and sensitive to traffic movements and volumes. Almost all fixed-time signals have now been replaced by vehicle-actuated ones while combined research by the Ministry of Transport and the two main British signal manufacturing companies has improved the flexibility of vehicle-actuated signals. For example, the latest type of signal controller already provides for automatic variation of:

(*a*) green time extension, according to the speed of the detected vehicle;
(*b*) minimum green periods, according to the number of vehicles waiting;
(*c*) all-red periods to suit certain traffic conditions.

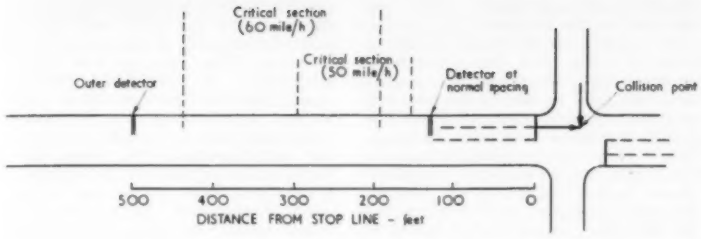
The Ministry of Transport is now considering an improved form of variable maximum period to suit traffic conditions on heavily trafficked roads (especially multi-lane roads) where signals often act virtually as fixed-time signals because of the heavy flow. At many intersections in cities the queue sometimes extends so far back that it interferes with the previous intersection and prevents movement of the cross traffic at this intersection during its allotted green period. A possible future development of vehicle-actuated signals may overcome this difficulty by locating 'presence detectors', which indicate the presence of a vehicle whether moving or stationary, in the roadway between the two intersections. These will prevent a green signal being given to an approach when the end of the queue from the junction ahead is too close. In these circumstances a left-filter arrow could be given to this approach and the full green shown only when the queue ahead has diminished. It is likely that increasing use will be made of presence detectors in cities to indicate when conditions are becoming congested and these could be made to operate suitable signals. More use may also be made of television for aiding traffic control at particularly difficult locations.

High Speed Roads

Present traffic signals may not be considered entirely suitable for high speed roads, as drivers may be driving at such a speed that, when the signals change to amber, they cannot stop in time nor can they, by continuing at the same speed, reach a safe point by the time the red period commences. There is a section (called the critical section) where a driver travelling at a particular speed would be in a dilemma if the lights changed to amber. (See Fig. 1.) For example, travelling at 60 mile/h. a driver would cover 264 ft. during a three-second amber: experiments have shown that 90 per cent of drivers travelling at 60 mile/h will stop comfortably if they are 440 ft. from the stop line when the lights change to amber. Therefore between 440 ft. and 260 ft. from the stop line a driver is uncertain whether to stop or to continue—in fact he may be unable to take either action with safety. With the present signal system vehicles register their arrival when they cross the detector pads (usually located at 90-130 ft. from the stop line) and their green time extension is started at this time. Thus drivers at medium and high speeds will have passed through their critical sections and will already have decided their course of action long before they reach the detector pads. Furthermore, the extension of green time, with many controllers, continues for seconds after they have actually passed through the intersection. It should be noted that a system known as 'double detection' is in operation which goes part of the way towards meeting the needs of high speed roads, though there are some disadvantages associated with it.

New Apparatus

A new apparatus has been devised by the Road Research Laboratory and is being developed jointly by two British signal companies. This apparatus will be used in conjunction with the latest type of signal controller. It will measure a vehicle's speed when it is 500 ft. away from the intersection and will delay placing a demand for an extension of green time until a certain period has elapsed; this period being equal to the time that it would take a vehicle to travel from this distant detector, at its measured speed, to the critical point at which it could no longer stop in comfort. If the lights change to amber before the driver reaches the point at which his demand is registered he should be able to stop in time. If the lights are still green when the driver reaches this point then his demand is placed in the usual way. Thus the effect is the same as having a detector at a variable position which depends on the speed of the vehicle. The driver therefore gets his



Note* A critical section is that section of road in which a vehicle at a given speed cannot stop in time if the signals ahead change to amber nor continue and clear the collision point before the red signal appears.

Fig. 1. Critical Sections for vehicles approaching traffic signals on high speed roads.

extension of the green time at the time he needs it. Furthermore he gets only the amount of green time extension he needs for safety and this lessens the chances of the maximum period expiring.

Pedestrian Signals

A zebra crossing works reasonably satisfactorily at low and medium flows, but when the flow reaches roughly 1,000 pedestrians per hour it has been found, in a few cases, that vehicular delay is reduced (though pedestrian delay is increased) when the zebra crossing is replaced by a signal controlled crossing. One disadvantage of the signal-controlled crossing is that in low or medium vehicular flows a pedestrian sometimes operates the push-button and then crosses during a gap in the traffic before the 'cross' phase begins, the traffic being subsequently brought to a standstill for no useful purpose. A method of overcoming this difficulty is at present under consideration. With this method the pedestrian would place a demand by holding down a handle or alternatively keeping a push-button pressed until he could cross. If the pedestrian released the handle (or button) to cross the road in a gap in the traffic the demand would be lost and the traffic would not be interrupted.

The Ministry of Transport is considering a method whereby signals would be installed at certain zebra crossings. The red period to traffic would be very short—just long enough to enable the pedestrian to start his crossing. This would be followed by a flashing amber when the normal rules of zebra crossings would apply. If a pedestrian crosses during a gap in the traffic stream, and before the start of the red signal to traffic, then traffic may be stopped unnecessarily but the delay would be negligible.

Signal Control of Roundabouts

Signals have been installed on an experimental basis at several roundabouts and the effect on delay, capacity and driving comfort have been observed. Whereas previously the roundabouts were liable to lock under heavy traffic conditions, resulting in complete blockage, long delays and the necessity for police assistance to sort out the vehicles, the tendency to lock was greatly reduced with the signals present. At the cost of a reduction in capacity the risk could have been completely removed by making the clearance periods long enough. Instead, the risk of locking was almost removed in the experiments by having a policeman present to extend the all-red period manually when locking appeared imminent.

Experiments are now being carried out with presence detectors placed in the approaches to indicate when certain sections of the roundabout are overloaded and to withhold the green period from particular approaches until the roundabout is able to accommodate more traffic. Further experiments are being carried out using a loop detector, surrounding the whole central island, to detect overloading and extend the all-red period until the level has fallen to a critical value (to be deduced by experiment). Experiments are also planned to investigate a new type of phasing for roundabouts. The entries of the platoons of vehicles from the various approaches are to be so timed that they exactly fit into gaps in the traffic circulating round the roundabout.

It is of interest to note that drivers have expressed the opinion that they prefer the more orderly flow, under signal control, to the free-for-all conditions of the uncontrolled roundabout.

Flow of Traffic through Signals

In ordinary linked systems of traffic signals, vehicles often arrive at the next intersection too soon, have to stop, and when starting up delay following vehicles travelling at the correct speed. In most linked systems the design speed varies from one block to the next and it is difficult for a driver to keep at the correct speed throughout the system. It has been suggested that intermediate 'advisory' signals could be placed between intersections so that drivers can keep 'with the green wave'. Experiments on these lines have been tried abroad. This would help, in particular, vehicles which have entered the system from the side road and are completely out of phase with the green wave. Starting delays should be reduced and capacity thereby increased. Though this may have only a small effect on capacity it is expected that driving comfort would also be improved.

At present many factors contribute to the disruption of the smooth flow of traffic, resulting in a lowering of capacity and an increase in delay and nervous tension. Included in these factors are:

(*a*) the presence of parked vehicles, particularly near controlled intersections;

(*b*) queues of waiting right-turners at intersections and

(*c*) the arrival of vehicles at linked traffic signals, out of phase with the progression.

It is desirable that efforts should be made to improve the smoothness of flow and driving comfort and such efforts might result in welcome developments in future traffic signal techniques. In many cases it may be uneconomic to prohibit right turns, but improved lane marking at signals could enable vehicles in the off-side lane to squeeze past waiting right-turners without encroaching on the nearside lane. Similar treatment might be applied to the problem of parked vehicles where it is considered unreasonable to prohibit parking. At present, where there are two lanes in the approach, drivers are often faced with the problem of deciding between the possibility of being baulked by parked vehicles, if they choose the near-side lane, or by right-turners, if

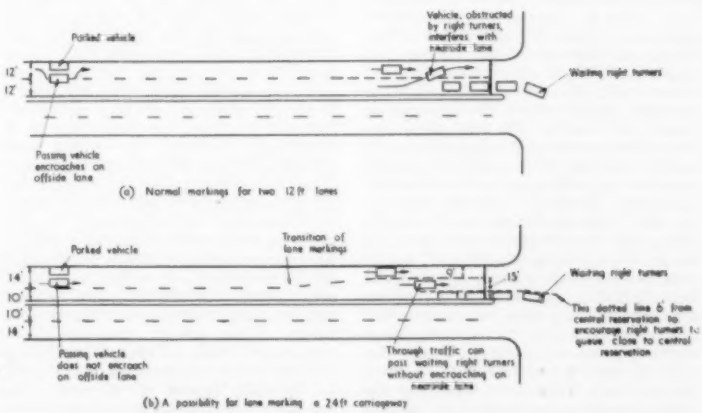

Parked vehicle
Vehicle, obstructed by right turners, interferes with nearside lane
Waiting right turners
12'
12'
Passing vehicle encroaches on offside lane
(a) Normal markings for two 12 ft lanes
Parked vehicle
Transition of lane markings
Waiting right turners
14'
10'
10'
16'
15'
Passing vehicle does not encroach on offside lane
Through traffic can pass waiting right turners without encroaching on nearside lane
(b) A possibility for lane marking a 24 ft carriageway

Fig. 2. Example of possible lane markings to improve traffic flow.

they choose the off-side lane. Apart from any other considerations it seems unwise to have the fastest lane of a highway blocked at intervals by waiting right-turners and switching from one lane to another, which inevitably occurs, is obviously undesirable from the safety point of view. Fig. 2 shows one possible lane-marking to improve smoothness.

Smoothness of flow and driving comfort may also be improved by making signals more conspicuous, especially on high speed roads and on roads where sun dazzle creates special problems. In addition, it might not be too difficult to increase the power of the signals in the day-time only.

The More Distant Future

When there is more traffic in one direction than in the other, it is preferable, theoretically at least, to reallocate the available lanes to suit the traffic. This means that certain lanes must be reversible and function in one direction at one time of the day and in the reverse direction at another time of day. This can be achieved either by signalling the lanes by means of overhead green or red lights or by using portable rubber cones (or movable barriers) to denote the median line between the two directions of traffic. In many respects overhead signals are more satisfactory than the other methods in dealing with this problem. It is possible that, as traffic increases and road space becomes even more valuable, more use may be made of reversible lanes. In an urban area as large as London there are many centres of employment where large numbers of people converge during the morning peak. This multiplicity of journeys in all directions tends to cancel out any tidal effects. In smaller cities, however, there is a general inflow of vehicles into the city centre in the morning peak period and an outflow in the evening peak period. The use of overhead signals could be coupled with detectors in the road so that the direction of the reversible lane could be determined automatically by the flow.

This principle of overhead signalling could also be applied in certain cases to the centre lane of three-lane roads. When a three-lane road is heavily trafficked, with more or less equal volumes in each direction, the capacity is little more than that of a two-lane road. This is because the amount of overtaking which is possible in the two directions simultaneously (using the centre lane) affects only a small fraction of the total traffic. A method of allowing greater opportunities for overtaking would be to divide the road into, say, one-mile sections and signal the centre lane in alternate directions in successive sections, but with a short all-red section interposed between adjacent sections in which the directions were towards each other. It is realized that this could be done quite simply with road markings, but the method using signals could be modified to suit the traffic e.g. if the flow becomes very tidal, all sections (not just alternate ones) of the centre lane could be given to the direction with the heaviest flow. Should there be a parked vehicle, or a breakdown, blocking the traffic stream in a single lane section then vehicle presence detectors, suitably placed, could be used to detect this condition and accordingly reverse the direction of the appropriate section of centre lane, thus allowing one lane in each direction past the obstruction. Alternatively, the centre lane signals could be used to denote priority only and not complete right of way. This would then allow vehicles in the single lane to carry out an overtaking manoeuvre if the centre lane were completely clear. It is difficult to say whether priority or complete right of way would be the safer method but it would be reasonable to suppose that both would be safer than the present method of equal priority for the centre lane.

Traffic Signals in Network

Proof has already been obtained that linking signals reduces delay when compared with isolated working. As traffic increases, more and more signals are installed in an area and it may become desirable, at some stage, to link together all the signals on certain well defined routes. Eventually these linked systems may join up or intersect with one another and form the basis of a network. Two possibilities are open:

(*a*) to increase the number of signals only as warranted by traffic conditions, linking where and when necessary;

(*b*) to add more signals, not necessarily justified by traffic, in order to complete a reasonable network which could be totally controlled by a central controller, which might be similar to an electronic computer. The first method might eventually lead to the second.

As the capacity of a system is approached, the benefits of linking tend to decrease and restrictions on parking, right-turning, etc. may have to be explored to increase the smoothness of flow which is so essential to a linked system.

Three Possible Methods

There are many possible methods of linking a network of signals and it is likely that the more basic methods will be explored. Three possibilities are illustrated below.

The first method is an extension of present practice. Knowledge of average flows and journey speeds, on different sections of the network and at various times throughout the day, could be used to construct master programmes. These could then be applied to the system either on a time basis or on the results of sample traffic counts at a number of strategic points within the system (as in Baltimore, U.S.A.). In either case vehicle-actuation of the local controllers could be used to provide a fine control on the settings. Preferential directions, i.e. favouring inbound traffic in the morning peak and outbound traffic in the evening peak, could also be provided for in the master programme. A large area could be divided into several sections each with its own master controller. The whole area could be controlled from a central operating station where the separate areas could be partially linked to prevent overloading of any particular section and to provide some continuity. The system could be elaborated by having vehicle presence detectors installed on many of the roads in the area, and possibly television cameras at certain important locations. The pictures and density information so obtained could be transmitted to the central operating station where changes in the master programme could be made (or temporary modifications to the programme), based on this information. Furthermore, fire, police and ambulance services could have radio contact with the operating station and could be given special treatment in urgent cases.

Obtaining master programmes to minimize overall delay to vehicles would be quite a difficult task. Several ways of linking simple systems are known already and simulations, on electronic computers, could be carried out to determine the best arrangements of signal settings as far as total delay is concerned, but the method would be very tedious and slow. Computer programmes have been developed in the U.S.A. and in this country to do this simulation, but experience in the U.S.A. has shown that, for a fairly complex system, the computation was too slow to be of real practical value. However, it is possible that some useful results could be obtained from simulations of some simple networks and these results could possibly provide working rules for dealing with more complicated networks. The possibilities of using analogue computers to simulate networks, should also be explored. Electronic 'bricks' could be used to simulate roads between intersections and intersections, and these could be built up to form any network. Variations in the parameters could then be made, to see the effect on delay. The advantage of an analogue method is that it may be easier to see the effect of changes in signal timing. The disadvantage is that separate pieces of equipment are required for each element of the network.

Seeking Higher Capacity

The second method tackles the problem from a completely different angle. The results of before and after studies in large cities have often shown that, when improvements are made to streets or intersections, the extra capacity gained by the improvement is sometimes absorbed almost overnight. Furthermore it has been observed that when conditions become too congested at one point traffic seeks other channels, and the net result is that most alternative routes are more or less equally loaded. Thus, the principle of this method is that an area could be signalled so that the street system, as a whole, had the highest attainable capacity. This may involve making certain streets one-way and bringing into force other restrictions with the sole object of improving the overall capacity quite independently of present traffic movements and volumes. It is quite possible that in a large urban area, like central London, traffic would reorientate itself after a while to fit in with such a system and there may be a resultant gain in capacity, coupled with a general easing of driving conditions brought about by more uniformity. It should be noted here that linking can generally be made much more efficient in a one-way street than in a two-way street and where an

area conforms to a grid pattern, alternate one-way streets can permit the use of known practical forms of linking.

A Game of Chess

The third method treats the whole problem in the manner of a game of chess. In one form of this method no master plans would be provided for the controller to work to, but at fixed intervals of time a decision would be made by a central computer whether or not each individual signal should change the right of way. This decision would be based on information fed to the computer from detectors installed on every leg of the network and capable of measuring flow and speed (or density). This information would be transmitted continuously to the computer. Certain other information such as the average turning movements at the intersections, turning movements under holiday traffic conditions etc. would be built into the computer programme. Thus, at any instant the computer would know how much traffic was on each section of the network and the average speed. From a knowledge of the average turning movements at each intersection for the particular time of day and day of week, the computer should be able to predict the traffic flows and speeds for the next few minutes, assuming a certain arrangement of signal timings. Various arrangements of signal timings should be considered by the computer and the one accepted which minimizes delay over the next few minutes. The computer should then start to put this 'accepted' programme into effect, changing the right of way at certain signals in accordance with the programme. A few seconds later the situation would be reviewed again by the computer and the whole procedure repeated, using the latest knowledge of flows, speeds etc. The programme previously devised would then be modified in the light of this fresh calculation and, bearing in mind that green periods are subject to upper and lower limits, new changes of right of way would be made. Every few seconds this computation would be made by the computer and the right of way changed at certain signals in accordance with this continuously modified programme.

The advantage of a scheme of this nature is that it can automatically take account of temporary bursts of traffic, e.g. the emptying of car parks, exhibitions, cinemas, etc., because the computer is continually making new decisions based on the latest traffic information. As in the first method, the whole system might be simplified considerably by division into smaller areas which are only partially coupled to one another. It is considered that writing the programme for such a scheme would be very tedious but should be possible. It is doubtful if computers exist at the moment large enough and fast enough to do the necessary computations in the space of a few seconds. It is quite likely, however, that once research has been really started on this problem a much simpler programme would be found to be satisfactory, e.g. it may only be necessary for the programme to work out the general plan for the following quarter hour, based on current flows and built-in knowledge of average flows for the time of day etc., and to correct this general plan as fresh information on flows and speeds is fed into the machine.

It has been occasionally suggested that area traffic control could be used to limit the amount of traffic entering the centre of a city by having signals on the outskirts of the central area, preventing vehicles from entering until there is room inside. Though something on these lines may be workable, it is doubtful if the method could be very successful. Many vehicles would be entering the area with the purpose of parking in off-street premises, others may be making journeys across one corner of the area and a scheme of this nature may unnecessarily hold up these vehicles on the outskirts when their presence within the area would not overstrain the traffic facilities of the area.

Summary

Possible future developments in the field of traffic signals have been considered. They fall into two groups: those which might be realized in the near future and for which most of the basic research has been done, and those about which it cannot with certainty be said, at this stage, that they are even worthwhile ventures. Considerable thought has, however, already been devoted to the possibilities in the latter category, but only a small amount of detailed investigation has been made.

Among the developments of the first category, described in this paper, are those designed:

(*a*) To continue to increase the flexibility and sensitivity of vehicle-actuated signals and to devise automatic methods of preventing the queues of vehicles at one intersection from interfering with other intersections.

(*b*) To reduce the dangers associated with traffic signals on high-speed roads by the development of a new type of controller (already devised) to take account of the higher speeds.

(*c*) To improve the efficiency of signal controlled pedestrian crossings.

(*d*) To increase the capacity of congested roundabouts and to improve driving conditions by the installation of traffic signals with special facilities appropriate to roundabout control.

(*e*) To increase the smoothness of flow (and therefore to improve driving comfort) in urban areas by improved lane markings, by the provision of new types of advisory signals and by increasing the conspicuity of traffic signals.

More distant developments include the use of signals to improve road efficiency when traffic is tidal and the paper discusses the signalling of certain lanes to provide automatically, at any time, the greater number of lanes in the direction of heavier flow. It is considered that this might be extended to three-lane roads to provide more opportunities for overtaking with increased safety.

Consideration is also given to the control of traffic in a complete network of streets by means of interlinked traffic signals. Several methods of controlling the signals in the area are discussed. In one method the signals operate according to one of several programmes, selected according to current traffic information fed into the central controller, whereas in another method there is no fixed programme, but the decision to change right of way at each intersection in the system is based on the calculations (made by a central computer) of predicted delays under various possible signal arrangements.' The calculations are repeated every few seconds with the latest traffic information, so that the decisions are continually being modified in the light of fresh traffic data.

DISCUSSION

In the discussion which followed, one speaker said that in the Ministry of Transport they had been concerned with much of the development work on vehicle-actuated signals which Dr. Webster had described, and they were hoping to issue very shortly a new standard specification for these signals. He added that speed timing had proved extremely successful and reliable in its latest form and had presented only one difficulty: when a very slow vehicle passed over the detector, or a pedestrian stood on it, they were detected as very slow vehicles and an excessively long green extension was given. The Ministry were planning to include a limiter in the circuit so that very long extensions would not be possible. This had the secondary effect of limiting slightly the range over which the speed timer was accurate.

Another speaker said he was not entirely satisfied about the methods which were being adopted on a high speed road to deal with the control and stopping of fast travelling cars. With an isolated vehicle they might be satisfactory, but he found it a frightening experience to drive towards a traffic light on a derestricted three-lane road at 60 m.p.h. with the light at green, not knowing, if it went to amber, what the man in front of him and the man behind him were going to do and having to decide what he himself would do. He did not see how any of the systems suggested would overcome that difficulty.

A further speaker dealt with the question of tidal flow and the various methods to achieve it used in North America. There were, he said, three methods, each dependent on different principles and differing greatly in cost of installation and maintenance, and also in efficiency. The first was used on Lake Shore Drive in Chicago, and was one in which solid kerbs could be raised and lowered mechanically at different times of the day to allow traffic in one direction to use two, four or six of eight lanes, depending on traffic volume. The principle involved was sound, and the system, from what he could learn, worked very efficiently when it worked at all, but the weak point lay in the simple mechanics of it and the result more often than not was that the kerbs which should be up were down, and vice versa.

Traffic Planning in Cumbernauld New Town

G. P. CROW, B.Sc., A.M.I.Mun.E., A.M.I.H.E.

Senior Assistant Engineer, Cumbernauld Development Corporation.

At the Institution of Civil Engineers Traffic Engineering Study Group on April 20 Mr. Crow opened a discussion on 'Traffic Planning and Design of Roads in Cumbernauld New Town' and his prepared paper is reproduced below.

CUMBERNAULD New Town is being built as a balanced community to assist the relief of overcrowding in Glasgow, the majority of its ultimate population of 70,000 coming from Glasgow under overspill agreements. The site occupies a strategic position in the valley which connects the Forth and Clyde at a point where north-south and east-west lines of communication meet. The total designated area is some 4,180 acres in extent, but building land suitable for comprehensive development is limited by the presence of deep glens, steep slopes, areas of peat, coal and fireclay workings. These physical restrictions reinforced the general planning concept for a compact urban centre for the initial 50,000 inhabitants, with high residential densities and no conventional neighbourhood units, located astride the broad hogsback of the principal hill.

Industrial areas are being developed on suitable ground to the north and east of the main hilltop and in the valley to the south. The additional 20,000 population will be housed in expansions of surrounding village communities and in a new village to the east.

The Original Road Pattern

The original plan drawn up to form the basis for the initial development of the town incorporated an outer ring road, running around the hogsback and linking up the areas allocated for housing; an inner ring road surrounding the proposed shopping and commercial centre; two main radial routes, one to the north and the other to the south-west; and various indirect links to the southern industrial area. The Glasgow-Stirling trunk route A80 formed the north-west boundary of the site and the realigned trunk route A73 by-passed the hilltop to the south-west. A comprehensive footpath network completely divorced from the main vehicle routes completed the whole pattern of communication.

Several preliminary studies were made to ascertain likely traffic movements on this system and, although somewhat rudimentary, they did give the first indication that even in a town of 50,000 to 70,000 inhabitants traffic was going to be a problem. They were sufficient to show that the road pattern should not be finalized until the situation had been analysed as thoroughly and scientifically as possible. Two things were obvious from these studies—that the majority of the town's traffic will be self-generated and that the largest single element making up the daily peak flows will be private cars used for the journey to work. For the purpose of the first detailed analysis it was therefore decided to concentrate on this one aspect—the journeys to work as they might develop over the next 20 years.

The First Analysis

The preliminary planning proposals indicated where people would work and live and in what numbers. In the first instance it was assumed that the homes of all employed persons would be evenly distributed throughout the housing areas within the town. To facilitate the route assignments and flow summations, the industrial and housing areas were divided into zones of convenient size arranged generally so that there would be only one acceptable route between each.

In essence, the analysis picked out every person about to leave their place of employment, decided where they would live, by what means they would travel home and then traced the route they would take. The selection of five major industrial areas and 20 housing zones produced 100 different groups of people each taking different routes between work and home. How they will travel will depend on many factors such as the level of car ownership, distance travelled, availability of public transport, the weather and a host of secondary motives. The assumptions eventually made to determine the mode of travel were based on projections of present day trends, but as these trends themselves are imperfectly established and documented in this country it is here that the greatest possibility of error lies.

The overall level of car ownership in the town assumed at the termination of a 15-year design period was 0.7 cars per family, allowance being made for the proportion of car owning families increasing with higher incomes and the higher income groups tending to make greater use of their cars. Motor cycles have always been included with cars since their effect on road capacity is much the same. Bicycles are not expected to create any major problems, because of the hilly nature of the site, but where they do warrant special provision, it is proposed that cycle tracks be provided alongside pedestrian routes.

Four income groups were selected, having different car ownership and usage characteristics, and these were allocated to different parts of the town according to the attractiveness of the individual sites and the type of accommodation planned. The size and characteristics of the groups selected are given in Table 1 below.

TABLE I

Group	*Percentage of total*	*Ownership characteristic*	*Usage factors*
I	2½	5 cars every 4 families	Nearly all used for work journey.
II	12½	1 car per family	Nearly all used for work journey.
III	50	3 cars every 4 families	75 per cent used for work journey.
IV	35	1 car every 2 families	67 per cent used for work journey.

The usage factors shown were modified to account for persons walking to work. Bearing in mind the hilly nature of the site, the assumption made was that anyone working within half a mile of home would walk. In practice, some people would be prepared to walk further, some less, but the mean effect is expected to be much the same. Reference to trends in the U.S.A. prompted a further assumption that the occupancy of cars used for the work journeys will be about 1.5 persons per car. Despite the fact that over one third of the employed population will work in industrial areas well outside the half mile limit, these assumptions produced the following proportions (Table II) travelling to work by each mode of travel.

TABLE II

On foot	7,000 persons	20%
Driving a car	9,000 ,,	26%
Car passenger	4,500 ,,	13%
By P.S.V.	14,500 ,,	41%
Total	35,000 persons	100%

The number of cars used by the 100 different groups of people previously referred to was determined by first applying the appropriate car ownership factors to the number of persons in each group, thus establishing the total who *could* travel by car, and then further applying the modified usage factors to evaluate the numbers who actually *would*.

The shortest and most convenient route home for each of these elements was traced and the flows of workers' cars on the proposed road system during the period of the homeward journey assessed by a process of summation, wherever the routes coincided. If this period is considered to be spread over approximately one hour, then the figures obtained give a direct reading, in vehicles per hour, of that portion of the peak flows consisting of cars used for the journey to work. Other elements accounted for were buses, commercial vehicles and other cars not involved in a work journey.

A theoretical approximation of the number of buses was found by assessing the number required to carry all workers who would not be travelling on foot or by car. By this method, the buses were found to form about 2½ per cent of the total peak flows. A separate study of commercial vehicle generation was not attempted, as the types of industry which Cumbernauld will attract are not yet predictable. A study of traffic census figures for similar sized towns revealed that near industrial or commercial centres the commercial vehicle content of peak hour flows is anything between 20 per cent to 50 per cent, and on main roads leading to housing areas between 10 per cent and 20 per cent. Allowing for the relative decline in the number of goods vehicles compared with cars, a figure of 20 per cent was selected to cover all additional vehicles that would be present on the radials and the inner ring and 10 per cent for the housing distributor ring road.

Communicating Traffic

One further factor was considered, that of commuting traffic. It is inevitable that some commuting will eventually develop between Cumbernauld and the surrounding communities, particularly with the parent city of Glasgow, 14 miles to the west. Limited studies of conditions in existing towns of similar size and situation show that the numbers commuting can be anything from 10 per cent to well over 30 per cent of the total working population. A figure of 20 per cent, both in and out, has been adopted for Cumbernauld. This will involve a daily exodus of about 7,000 people balanced by a similar number coming in to work. There are three potential commuting lines and the distribution between these lines was weighted in proportion to the population in each of the three sectors within a radius of 15 miles. The proportion of commuters driving a car was taken a the same as the average for town workers, but an average occupancy of two per car was assumed. Conditions which might arise on Saturdays and Sundays were investigated but with the possible exception of the town centre on a Saturday afternoon, the flows envisaged were not as critical as normal week-day peaks.

Results of the First Analysis

These studies revealed a prospect of staggeringly high traffic volumes during the peak hour on certain sections of the road pattern proposed—the western radial, linking the town with the trunk route to Glasgow, bearing over 3,500 v.p.h. and the other two radial routes, to the main industrial areas, nearly 3,000 v.p.h. The most significant revelation, however, was the fact that the inner ring road, with eight junctions, would have to cope with over 3,000 v.p.h. on the north and west sides and at least five of the junctions would involve multi-level treatment to avoid congestion, unless vast surface roundabouts capable of handling up to 4,500 v.p.h. on a weaving section were acceptable. At this juncture, the comments of the Road Research Laboratory were obtained, as it was felt that either the analysis was very much an overestimate or alternative solutions to the central area roads would have to be worked out. The views expressed were most useful and encouraging. They were of the opinion that, if anything, the analysis tended to be an underestimate, but particularly significant was their suggestion that consideration should be given to separating local through traffic from traffic which had a destination in the town centre.

More detailed analysis confirmed the presence of very large volumes of traffic which had no business in the town centre and that the conditions in the junctions were being exaggerated because some streams had to pass

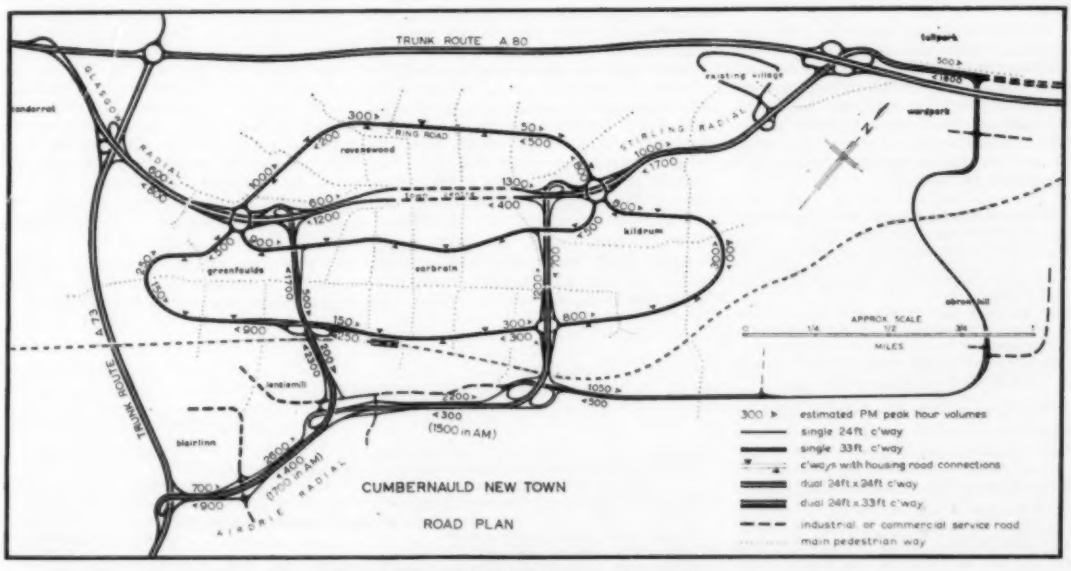


Fig. 1. Estimated traffic flows and proposed layout.

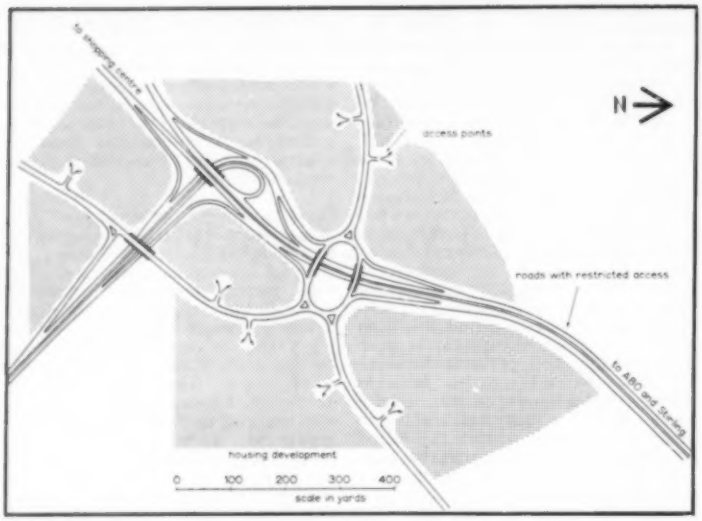


Fig. 2. Cumbernauld New Town. Typical traffic interchanges.

through a number of these in succession. To assist in the development of a more suitable pattern, desire line diagrams were prepared using the origin and destination data assembled in the original analysis.

Against this background, certain basic requirements were apparent. As might be expected, the diagram highlighted a strong pattern radiating through the full circle from the town centre and V-shaped patterns radiating from the two industrial areas, both heavily reinforced on the commuter lines. Obvious road lines appeared wherever these elements coincided, which they did on a north-south and a west-south axis on either side of the centre and on large sections of the outer ring route.

During these processes too it became apparent that the functions of the various roads should be kept absolutely clear cut and a principle of a hierarchy of roads has been adopted, each displaying individual characteristics and to which different design standards are to be applied. The hierarchy involves four categories of highway:

(i) Development roads with associated footways, frontage access etc.
(ii) Distributor roads (e.g. the outer ring) with frequent junctions with development roads but no frontage access or footways.
(iii) Radial roads with selected points of controlled access with the distributor roads.
(iv) Regional trunk roads linked to the radials at three points only.

The principle is not new, though its adoption is unfortunately rare. It is, in fact, a realistic and objective interpretation of paragraph 325 of the Ministry of War Transport's 'Design and Layout of Roads in Built-up Areas', in which the significant passage is, 'streets which are extensively used by pedestrians should not be traversed by traffic other than that having business in them.'

Revised Road Pattern

The revised road pattern, eventually produced in co-operation with the architects and planners, is an adaption of an ideal pattern based on the desire line diagram, modified to suit site planning requirements and the topography. It retains the outer distributor ring, skirting the main hilltop housing areas, and introduces an intermediate route, of the same character, longitudinally across the broader southern slopes. The development roads in the form of loops and culs-de-sac are all connected to these roads, but in no case do they link up transversely across the site to form short cuts. Superimposed on this system are three radial roads, one coming into the town on the Glasgow side (west), another on the Stirling side (north-east) and the third on the Airdrie side (south). The first two are linked together along the hogsback by means of a by-pass (on a vertical plane) of the proposed linear town centre and the third divides as it approaches the industrial area on the south side, the arms linking up with the first two radials at each end of the town centre. Interchanges with the distributor roads are provided wherever they are crossed.

The total length of main roads (radials and distributors) within the town is only 11½ miles, a relatively small figure for a town of its size, but consistent with the need to conserve as much space as possible for development purposes and with the principle of concentrating as much vehicular traffic as possible on to roads specially designed to promote free flow and safety. On this score an interesting, if not strictly true, calculation has been made of the savings that will accrue to the local community if the proposed road system effects only a 50 per cent reduction in the cost of delays and accidents, over those arising on a system which reflected the average standard of inadequacy at present existing throughout the United Kingdom. Many and varied estimates have been made to assess the overall cost of delays and accidents on the roads of this country. The most realistic put the costs at £500 million and £190 million per annum respectively. On a population basis, Cumbernauld's share of this wastage, if road conditions were average, would be £938,000, i.e.

$$£690 \text{ million} \times \frac{70{,}000}{51{,}500{,}000}$$

Thus if half of this amount is saved annually, in ten years the total amount saved would be greater than the capital cost of the whole road system.

The Revised Analysis

As a result of the modification of the road pattern, the route assignments and flow summations had to be revised, in order to test the efficiency of the new pattern and provide the basic data for interchange design. The method employed was essentially the same, modification being confined to a few details. In particular, a tendency for people to live as near as possible to their place of work has been allowed for. This tendency is in any case precipitated by the fact that the first housing and industrial developments are taking place at the northern end of the site.

This revised analysis revealed that the same high volumes of traffic can be anticipated on the inner length of the radials, but the heavy cross town streams will be subjected to a minimum of interruptions. There are now only 10 junctions on all the main roads within the town, as opposed to 20 on the previous plan. Traffic passing through these points is expected to be much the same as before but turning movements are naturally greater. Grade separation is justified on purely economic grounds on the majority of junctions, and the character of the radials, plus a need for continuity and standardization, warrants its adoption on them all.

The magnitude of the predicted traffic flows at a number of analysis points are shown in Table III below.

TABLE III

Location	*Mixed v.p.h.*	*p.c.u's/hr.*
Glasgow radial, inside the outer ring route	2,700	3,300
Stirling radial, beyond the outer ring route and en route to the northern industrial area	2,500	3,000
Stirling radial, inside the outer ring route	2,900	3,500
Airdrie radial, en route to part of the southern industrial area	3,100	3,700
Radial link, west of town centre	2,400	2,800
Radial link, east of town centre	2,100	2,500
Ring road approaching Glasgow radial on N.W. side. (The maximum figure appearing on the ring route)	1,050	1,200

All the interchanges have been designed to give the heaviest streams of traffic the most direct route through them. The projected programme includes three two-level roundabouts, and a partial clover-leaf at the four points where the radials and ring road meet, and three trumpet junctions where radial joins radial.

In translating the estimated peak flows into the required road layout, lane capacities of 1,000 v.p.h. have been selected for the dual-carriageway radial routes. Roundabouts have been designed on the basis of Wardrop's method and formula using 75 per cent of the maximum capacity thereby obtained. The maximum flow anticipated on the outer ring route is about 1,000 v.p.h. and where this occurs the flow will be almost entirely in one direction. On other sections where the opposing flows are about equal, the maximum total (both directions) is less than 700 v.p.h. Under these conditions a 33 ft. undivided carriageway is deemed adequate and, for the sake of continuity, this width is retained throughout the entire length. This width has also been adopted for the intermediate distributor.

Realization

By the end of 1961 about 1,200 new houses will have been built and occupied and work will have been provided for nearly 2,000 people. The greater part of the outer ring road on the north side is complete now and the eastern section is in course of construction, along with part of the intermediate distributor road. This summer, work will commence on the first two-level roundabout and trumpet junction on the Stirling radial. Although these had originally been planned for construction in stages, they are now to be completed immediately. The decision to do this, despite the fact that traffic generation within the town will be insufficient to warrant such complexities for many years, is based on:

(i) the fact that all earthworks must be carried out at once if the comprehensive landscaping is to mature along with other developments;

(ii) trunk road traffic from the A73 must be temporarily diverted through these interchanges as soon as possible, to free the land, over which the existing road passes, for housing development.

Apart from this, a detailed phased construction programme has been drawn up for the next five years, by which time the basic framework will be substantially complete and all parts of the designated area will be accessible for development.

Conclusions

The fact that a town of 70,000 population has been shown to require a major road system, provisionally estimated to cost about £3½ million, a sum which will probably include the cost of 10 two-level interchanges, is particularly significant when compared with the facilities at present existing in other much larger towns.

The main principles that have been established in Cumbernauld are:

(i) that the all-purpose road is the least suitable for the efficient and safe circulation of the ever growing volumes of traffic;

(ii) the random application of the ring road theory may not give the best results, particularly in connection with the development of the central business centre;

(iii) any road proposals should be based on detailed scientific studies of traffic movements and incorporate realistic estimates of future traffic increases;

(iv) the planning of new traffic facilities should always be considered in conjunction with the overall development of the surrounding areas. In Cumbernauld this has been achieved by teamwork between members of many professions, including engineers, architects, town planners and landscape architects, all working under the technical leadership of one man.

So far, all studies have been based on the assumption that the car ownership level in the fully developed town will be about 0.7 cars per family. It is now becoming increasingly obvious that saturation level for the country as a whole will not be reached until the figure has increased to one car per family, or even higher. The effect of such an increase in Cumbernauld is now being investigated. There may be some factor of safety inherent in the proposed scheme due to the fact that only a very limited staggering of working hours is anticipated. On the other hand, the assumed extent of car usage is low compared with most American towns of similar size, and indeed with some towns in this country today. It is therefore imperative, even with such seemingly generous traffic facilities, that equal attention be paid to establishing a good public transport service. In a town like Cumbernauld, such a service can only hope to succeed if it provides a form of transport as convenient, quick, clean, comfortable and cheap as the private car. In another direction every effort must be made to encourage pedestrian movement in all weathers by the provision of a co-ordinated and attractive system of footpaths along direct routes.

DISCUSSION

A speaker in the discussion which followed said that he found the greatest interest in the way a group of people had sat round a table and assumed certain dispositions of housing, industry and other elements of a plan, worked out the kind and quantity of journeys that would be made and deducted from these facts the type and dimensions of the road scheme they required. The process was not wholly original, but the difference between the basis of ring road plans which blossomed out after the war and the present use, seemed to be that genuinely probably journeys had been considered.

He asked Mr. Crow whether he though it was true that the kind of analysis which had been done in Cumbernauld could be adapted for an existing town. It had always seemed curious to him that they had known comparatively little about the kind of journeys and circulations made by motor vehicles within existing towns. He knew that origin and destination surveys had been made for many years, but they had usually comprised little more than investigations, at a rather limited number of peripheral points, of the broad origins and destinations of traffic, and little had been revealed about what was in truth a pattern of great complexity. A mental exercise on the lines of the Cumbernauld survey might be very revealing, though, of course, one could see certain difficulties. One main difficulty would be the great scatter of destinations that arose in existing towns. He imagined that the Cumbernauld study had been possible largely because a comparatively simple set of destinations had been justified with a comparatively simple concentration of traffic along a few routes.

One of the main complications which arose in existing towns was the scatter of the town centre, and there had been a simplification of that in the case in point. He thought the town centre at Cumbernuald was the most interesting aspect of the whole plan. One could describe the town centre as like a great ocean liner with the cross road running through the holds. Above it was built the long, linear, multi-deck town centre which was like the Queen Mary perched above the roadway. He imagined that this kind of town centre had resulted in a concentration of destinations and very much simplified the circulation problem.

One advantage about this kind of study for an existing town was that one could check, by means of on the spot observations, how one was getting along. However, in the case of Cumbernauld they would not really be able to check until it was too late, when it was complete and the traffic was flowing, although there might well be critical stages during development when they could check.

He noticed that the calculations were all based on a certain assumed level of car ownership at the end of the 15-year design period. From that it emerges that some 41 per cent of the total persons travelling to work would do so by public service vehicle, and in this context the Cumbernauld study was was very useful in showing what was needed for a certain level of motorization. If the analysis was correct—and he saw no reason to doubt it—then it certainly made one quail for some of the conventional rings and roundabouts that one saw proposed, and in some cases completed, round the country. He concluded that not least important was the partnership between the professions, and that was something which had to be elaborated and developed much more.

A report of the discussion on Safety Aspects of Motorway Design opened by W. F. Adams, Ministry of Transport, will be published in the July issue.

WORLD TRAFFIC ENGINEERING CONFERENCE

THE programme for the Conference on Traffic Engineering, which is being held in conjunction with the Annual Meeting of the Institute of Traffic Engineers at Washington, August 21-26, 1961, has now been completed as follows:

Theme I:

The need for scientific research in traffic engineering and the desirability of international co-operation in promoting it.

Chairman:

A. Rumpler, Chairman of the OTA/PIARC/IRF Joint Committee, President of the PIARC, Director of the IRF, Paris.

General Reporter:

Sir William Glanville, Director of the Road Research Laboratory, Great Britain.

Reporters:

N. Bruzelius, Director, Road Research Organization, Sweden.

Prof. H. M. Edwards, Professor at Queens University, Kingston, Ont., Canada.

Fred W. Hurd, Director, Bureau of Highway Traffic, Yale University, U.S.A.

Prof. J. Schlums, Technische Hochschule, Hanover, Federal Republic of Germany.

Theme II:

Urban transportation and its future.

Chairman:

J. F. A. Baker, Chief Engineer (Highways), Ministry of Transport, Great Britain.

General Reporter:

Edward H. Holmes, Assistant Commissioner for Research, Bureau of Public Roads, U.S.A.

Reporters and panel members:

J. Elkouby, Roads and Bridges Engineer, Ministry of Public Works, France.

M. Jenni, Assistant City Engineer, Zurich, Switzerland.

Prof. B. Wehner, Technische Hochschule, Berlin, Federal Republic of Germany.

Luiz Ribeiro Soares, Chief of Mass Transit Planning, Rio de Janeiro, Brazil.

Frank W. Herring, Deputy Director, Comprehensive Planning, Port of New York Authority, U.S.A.

Don C. Wagner, Managing Director, City Hall, Philadelphia, U.S.A.

J. Douglas Carroll, Jr., Director, Chicago Area Transportation Study, U.S.A.

D. Grant Mickle, Director, Traffic Engineering Division, Automotive Safety Foundation, U.S.A.

Theme III:

Design of interchanges on rural freeways (motorways).

Chairman:

Hermann Baumann, President, Highway Association, Peru.

General Reporter:

Charles M. Noble, Consulting Engineer, Princeton, U.S.A.

Reporters:

F. Heller, Ministry of Transport, Federal Republic of Germany.

E. Goelen, Ministry of Public Works, Belgium.

A. Thiébault, Motorway Planning Section, Ministry of Transport, France.

J. G. Smith, Ministry of Transport, Great Britain.

Henry George, Divisional Engineer, County Roads Board, Victoria, Australia.

Dr. Hiromasa Sato, Highway Public Corporation, Tokyo, Japan.

Raphael Cal y Mayor, Road Association, Mexico.

William A. Bugge, Director of Highways, Washington State Highway Commission, U.S.A.

George A. Hill, District Engineer, California, Division of Highways, U.S.A.

Theme IV:

Research into highway traffic accidents.

Chairman:

Charles W. Prisk, Office of Research, Bureau of Public Roads, U.S.A.

General Reporter:

R. Coquand, Director of Roads and Traffic, Ministry of Public Works, France.

Reporters and panel members:

P. Lefèvre, Chief Roads and Bridges Engineer, Ministry of Public Works, Belgium.

S. Goldberg, Roads and Bridges Engineer, Ministry of Public Works, France.

Dr. R. J. Smeed, Deputy Director, Road Research Laboratory, Great Britain.

Karl Moskowitz, Assistant Traffic Engineer, California Division of Highways, U.S.A.

Theme V:

Use of electronics in traffic control.

Chairman:

H. Hondermarcq, Director General of Roads, Belgium.

General Reporter:

Henry A. Barnes, Commissioner, Department of Transit and Traffic, Baltimore, U.S.A.

Reporters:

Dr. G. E. E. Vacca, University of Rome, Italy.

Khan Saheb Pathan, Traffic Control Department, Bombay, India.

J. G. Wardrop, Road Research, Laboratory, Great Britain.

Dr. G. Littmann, Chief of Police, Frankfurt-am-Main, Federal Republic of Germany.

O. K. Normann, Deputy Assistant Commissioner for Research, Bureau of Public Roads, U.S.A.

Daniel L. Gerlough, Senior Staff Engineer, Ramo Wooldridge Inc., California, U.S.A.

Theme VI:

Freeway (motorway) operation.

Chairman:

Prof. C. Chiodi, President of the Touring Club, Italy.

General Reporter:

K. Vaughan-Birch, Director, Traffic Division, Engineering Department, Vancouver, Canada.

Reporters and panel members:

F. Rickenberg, Celle, Federal Republic of Germany.

Antonio Berti, Director General of Serrovalle-Milan Autostrada, Italy.

Edmund R. Ricker, Chief, Traffic Engineering Bureau, Pennsylvania Department of Highways, U.S.A.

Participants who enrol for the World Traffic Conference will be also invited to attend the 31st Annual Meeting of the Institute of Traffic Engineers, as well as the International Sessions in Traffic Engineering. Participants will also have the opportunity to take part in a six-day Study Tour by coach.

The Conference is being organized jointly by the Institute of Traffic Engineers (United States), World Touring and Automobile Organization (OTA), Permanent International Association of Road Congresses (PIARC) and International Road Federation (IRF). Full details can be obtained from the World Touring and Automobile Organization, 32 Chesham Place, London, S.W.1. Details of the enrolment procedure will tl.·n be sent.

I.R.F. World Congress

The IV World Meeting of the International Road Federation is to be held in Madrid, November 1962. A considerable part of the meeting is to be devoted to traffic engineering matters.

CENTRAL DEVELOPMENT NEWCASTLE UPON TYNE

Redevelopment proposals for the Central Area of the City and County of Newcastle upon Tyne were presented in a report by the City Planning Officer, Mr. Wilfred Burns, in March, from which extracts with particular regard to the traffic aspects are reproduced below.

NEWCASTLE is not only a city with its ordinary problems but is the centre of a large region. It must continue to provide the regional central area facilities even though surrounding towns may be expanding their own facilities. This is true not only in respect of shopping but in offices, culture, entertainment and sport. The Central Area is characterized by low density residential population, a large concentration of employment in shops, offices and warehouses and by traffic congestion and car parking problems. The majority of the buildings in the City Centre were built in the nineteenth century and many of them are now in a state where redevelopment has become a matter of considerable urgency. Mixed uses occur in many areas and this helps to spread the blight which arises from the condition of the buildings themselves. In addition to all this is the much talked of traffic problem which calls for radical solutions if convenience is to be restored to all Central Area users. Traffic will perhaps increase by two or three times in the foreseeable future and conditions can be expected to deteriorate rapidly if action is not taken.

The age structure of the Central Area indicates quite clearly that redevelopment, when it commences, will be a large scale undertaking to be carried into effect in a relatively short period. In most city centres, other than those which suffered extensive war damage, the process of redevelopment is a very slow one operating against the background of a comprehensive plan, whereas in Newcastle the total age of the centre undoubtedly creates the conditions for wholesale redevelopment which will permit the production of a virtually new centre within a short period. In the plan which is now put forward, an attempt has been made to keep the best of the old development, and it will be the aim to integrate the new into the old City in a way which gives continuity. The plan indicates ways in which the river area could be brought back into the City's life. It is expected that the shopping centre will develop as a truly regional and specialized centre and that it will need to expand.

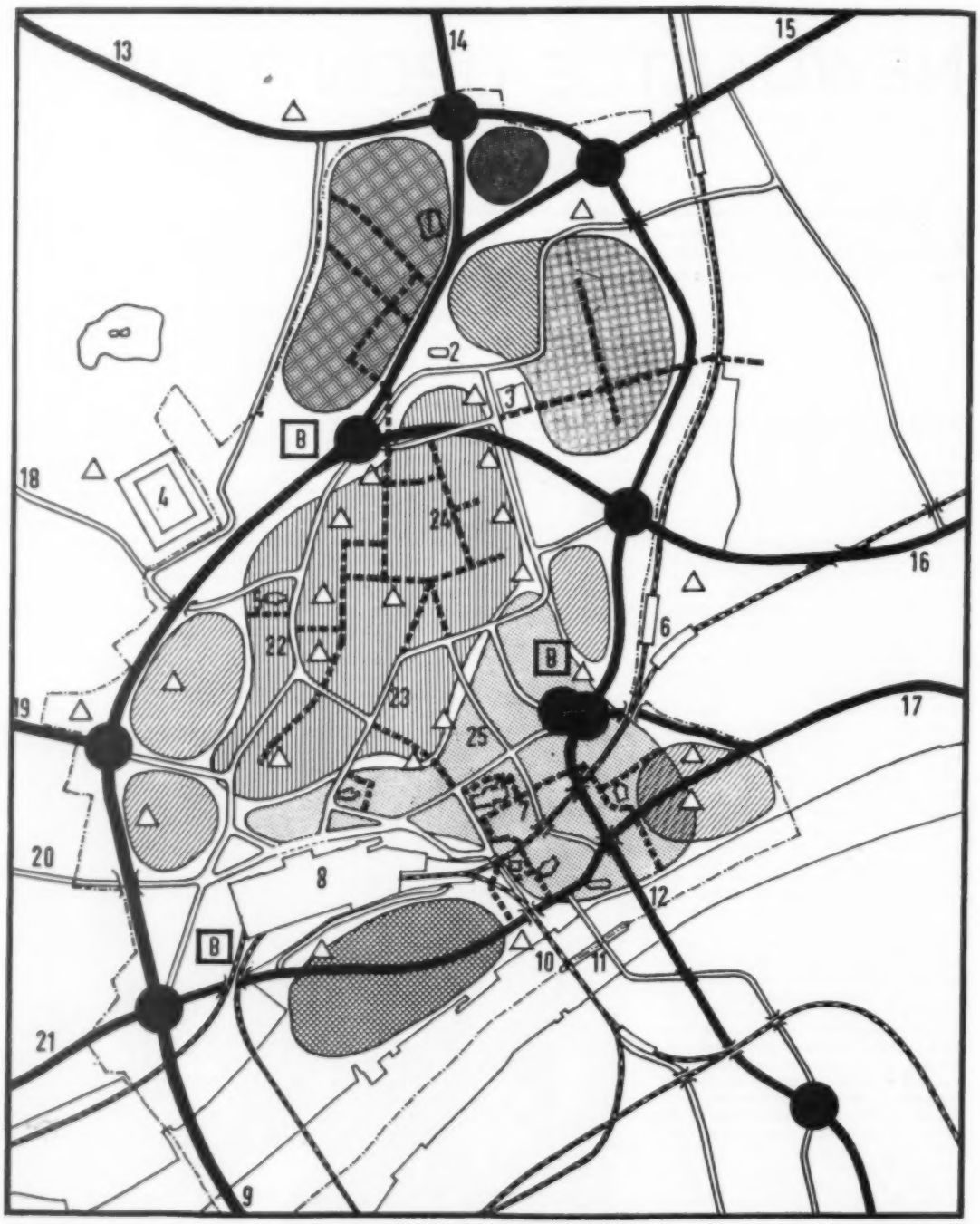
Traffic solutions can only be found by the provision of limited access, free flow roads, taking away from the business core the vehicles not wishing to remain within that area, and the plan therefore proposes an urban motorway system. Slow moving inner circulation traffic is separated from the traffic passing through the Central Area or proceeding rapidly to a Central Area destination, and all traffic is separated, as far as possible, from pedestrians. Adequate provision, it is hoped, can be made for the static vehicle in a way which will

Traffic congestion in Northumberland Street, Newcastle upon Tyne.

NEWCASTLE UPON TYNE POLICY MAP

of the Proposed Redevelopment of the

CENTRAL AREA



NOTATION

Shopping

Offices

Warehousing

Warehousing & Industry

Civic

Education

University

Government Buildings

Boundary of Central Area

Car Parks

Bus Stations

B

Central Motorways

Major Routes

Pedestrian Routes

Major Traffic Intersections

1. Hancock Museum
2. St. Thomas' Church
3. City Hall
4. St. James' Park
5. St. Andrew's Church
6. Manors Station
7. St. Nicholas Cathedral
8. Central Station
9. New Redheugh Bridge
10. High Level Bridge
11. Swing Bridge
12. Tyne Bridge
13. Claremont Road
14. Great North Road
15. Jesmond Road
16. New Bridge Street
17. City Road
18. Barrack Road
19. Westgate Road
20. Westmorland Road
21. Scotswood Road
22. Newgate Street
23. Grainger Street
24. Northumberland Street
25. Grey Street

not destroy the character of the shopping centre. The plan also attempts to sort out the various conflicting land uses into a logical pattern for development.

Analysis of Traffic Surveys

The first important traffic survey carried out in the City was in 1959 when the origin and destination of vehicles crossing the Central Bridges (Tyne, Swing, High Level and Redheugh) was found by direct interview. This was followed in 1960 by a very large scale origin and destination survey and by subsidiary vehicle counts in central streets. The analysis of all the data collected will take many months but, for the purpose of this report, a broad analysis has been made of certain important Central Area traffic considerations, so that the validity of the proposals to be put forward for the new road pattern can be seen in relation to estimated traffic volumes.

In arriving at the assessment of future problems in the City, account must be taken, not only of the possibility of the amount of traffic using the centre increasing because of the increased importance of the centre, but also an increase in traffic to cater for increasing car ownership. It is normally accepted today that one should base plans and policies on traffic increasing to two and a half times present day volume.

There are at present between 80 and 90 thousand passenger car units (i.e. cars plus an appropriate allowance in terms of cars for buses and lorries) crossing the river by the central bridges every day. The survey shows that of the traffic travelling from the south very roughly half needs to get directly to the northern sector of the City (i.e. including the northern sector of the Central Area), a quarter of the traffic from the south is tending to go in a westerly direction and the other quarter in an easterly direction. The amount of through traffic, i.e. traffic passing right through Gateshead and Newcastle in a south/north direction, is very small indeed, and the real traffic problem in the City is caused by the local movement of traffic between Gateshead and Newcastle, with a smaller amount of long distance traffic terminating in or near the centre. If traffic increases as expected in the future, it can only be coped with by a free flow over the Tyne Bridge, full capacity through the High Level and Swing Bridges and by an additional bridge with a capacity considerably greater than that of the Tyne Bridge. If traffic increases more than these bridges and the Central Area can comfortably cope with, it may be necessary to consider relieving the centre by constructing a further bridge downstream.

Directional Flow

The survey indicates there is no marked bias between traffic flowing from the south to the east and to the west. The main flow from the centre of Gateshead, as defined in the survey, probably results from the high density residential areas lying mainly to the west of the Great North Road. The Team Valley Trading Estate is also to the west of the Great North Road. As far as Newcastle is concerned, the centre of gravity of the shopping centre is to the west of the A1, but if any future substantial extensions are made in a westerly direction, the centre of gravity of the shopping centre may move further westwards. The indication is, therefore, that any new large bridge to take the increased volume predicted could well be sited to the west of the Central Area and, since the Redheugh Bridge needs to be reconstructed, the opportunity can be taken of providing the new Redheugh Bridge as part of a new central motorway system.

Total Journeys

In considering the plan for the Central Area as a whole, regard must be given also to traffic flowing east and west through the City Centre as well as that flowing north and south. In fact, the survey shows that the total flow into and out of the Central Area in a twelve hour day covers something over 180,000 passenger car unit movements, so that the problem is clearly not just that of providing an adequate crossing of the Tyne, with its cross river flow of 80,000 to 90,000 passenger car units.

The tentative analysis of east/west traffic flow shows that substantial new road provision is required to cope with the anticipated volume. At this stage, traffic volumes are difficult to estimate because any roads through the centre in an east/west direction will, of course, also carry a very substantial volume of local circulating traffic. It may be, however, that something like half as much traffic as that passing over the four Tyne bridges in an east/west direction will need to be catered for.

Proposed Road Pattern

The major function of the new road system suggested is to enable all traffic wishing to pass between one side of the Central Area and another to do so easily and speedily without choking the Central Area streets, which have their own particular function. In order to do this a new system of main distributor roads around the Central Area will be required. This system will be referred to as the Central Motorway System and its principal function will be to ensure that traffic having no business in the Central Area will be diverted around it; at the same time these roads will act as distributors, ensuring that traffic needing to enter the Central Area will be able to do so freely at the point of entry closest to its destination. Furthermore, traffic passing directly through the City and cross-town traffic will have no cause to enter the inner core.

All traffic which enters the Central Area in the future must be traffic which has essential business in the centre, and the road pattern suggested for the area within the proposed central motorway system is designed to serve four major purposes:

(*a*) A substantial provision within the central motorway system mainly for short-term parkers.

(*b*) Longer-term parkers should be provided with multi-storey car parks close to the central motorway system.

(*c*) The number of vehicles using the inner core and the central car parks should be regulated by altering the time limit for parking.

The main north-south and east-west distributor roads should be designed as urban motorways. They would then have no frontage development and access would be possible only at the major junctions. In these circumstances it should be possible to design these roads for speeds of between 35 and 40 miles per hour, but it must be remembered that they will be connected to roads which are already in existence and which have lower speeds. Pedestrians would be completely separated from these new roads and it is hoped to be able to arrange bus services so that there would be no setting down or picking up of passengers.

Proposed Internal Street Pattern

The function of the city streets has already been defined as providing circulation between various parts of the City Centre, providing access to car parks and service to buildings, and providing routes for public service vehicles which will bring their passengers as near as possible to the shopping and business areas. It would be wrong, however, to think only in terms of traffic when considering the Central Area internal road pattern. Consideration must be given to the needs of the pedestrian within the Central Area and in particular to the needs of the shoppers within the major shopping areas. With these objects in mind, therefore, it is proposed to create three major precincts within the Central Area, each surrounded by a series of city streets which would carry the bulk of the traffic circulating round the precincts. Traffic would be able to enter these precincts only for the purpose of gaining access to car parks or servicing buildings, and the major portion of the circulating space within these precincts would be allocated solely to pedestrians in areas completely separated from vehicular traffic. The most important of these precincts will be that containing the major shopping area. Moreover, all roads within this area would be closed to through traffic and those which are retained should be used for service purposes only. It will be a feature of the redevelopment of much of the back land that new service ways will be provided in order that rear service can be given to both existing and redeveloped property along the lines of these streets.

Substantial car parking will have to be provided within the circulating road and as close as possible to the main shopping area. The intensity of use and value of land in this area will be such that it will be impossible to provide car parking on the basis of surface car parks. In general terms, it is anticipated that this car parking will have to take the form both of multi-storey car parks and, where provided in the redeveloped shopping area, of a two level circulation system, the lower level providing service ways and car parks for the shops and the upper level being available for pedestrian use only.

Two further but smaller shopping precincts will be provided. Both will have all through traffic eliminated, and existing streets in these areas will be used either for servicing buildings in the area or will be closed and used as pedestrian routes.

Traffic and the Pedestrian

Considerable importance is placed upon the separation of pedestrians and traffic in the Central Area. An overwhelming case can be made out for such separation on road safety grounds alone, but of equal importance is the necessity to create new shopping and business areas where the pedestrian can regain his rightful place as the major user of the area, and where he may go about his daily business without the noise, inconvenience and danger from traffic. Within these pedestrian areas a whole new field of urban design can be developed to provide the City Centre with an environment giving pleasure and delight to its users.

The three major internal circulating routes suggested will have common boundaries with each other, and it will thus be relatively easy for traffic to interchange. These points of interchange will require junctions capable of dealing with a fairly heavy traffic load. It may be possible, by using existing streets as one way streets, to develop a series of large sized islands at these junctions. In these circumstances a free flow of vehicles throughout the Central Area streets could be achieved, but it may mean that pedestrians wishing to cross the main circulating routes would experience some difficulty, since vehicles may be expected to be travelling at speeds faster than at present. In these circumstances thought may have to be given to the provision of a number of underpasses. An alternative solution may be to control each of these junctions by a traffic light system, in which case the traffic would be automatically broken into groups and the problems of pedestrians crossing the roads would be considerably eased.

It is not considered necessary for these Central Area streets to be designed for speeds in excess of 20 m.p.h., and it will be an aim of the design to see that the speeds are kept deliberately low so as to encourage as much through traffic as possible to use the central motorway system and to ensure the greatest overall efficiency and safety. A deliberate attempt has been made to stop any possibility of easy direct crossing of the Central Area. In this way one can ensure that the Central Area streets are retained for use only by vehicles having genuine business in the Central Area.

Public Service Transport

The plan for the City Centre should make provision for public service vehicles to get as close to the pedestrians' destination as possible, and certainly closer than the long-term car parks. This will be achieved by having certain streets reserved entirely for buses so that they can proceed through the City Centre without difficulty. All bus loading points should be designed in loading bays where streets are not specifically reserved for this purpose.

There should be three main bus stations serving the Central Area. Buses, other than the local ones, should use the central motorway system to gain direct access to these bus stations and should not enter the central streets.

Parking provision

Parking space for short-term and long-term users should be provided to meet an ultimate peak demand of 17,000 cars. The car parking system should be based on:

(*a*) Easy circulation of essential traffic between the various parts of the Central Area.

(*b*) Ready access to car parks.

(*c*) Adequate servicing to all buildings, without creating congestion on the main streets.

(*d*) Routes for public service vehicles to serve all the major parts of the Central Area, thus enabling a high standard of service to be maintained for the public.

The car parking system will be made to work satisfactorily by enforcing time limits and this will be done by regulations and/or a system of charging, but charges should be low enough so as not to act as a deterrent to would-be shoppers.

NEW OFFICERS

Christopher T. Brunner was elected Chairman of the Council of the International Road Federation, London office, on the retirement of Sir Reginald Biddle, C.B.E., J.P., at a Council meeting of the I.R.F. on April 17.

Mr. Brunner is a member of the honorary Editorial Advisory Board of *Traffic Engineering & Control*, Vice-Chairman of the British Road Federation, a Past President of the Institute of Transport, and among his other appointments he is Chairman of the Road Research Board Committee on Economics.

James Amos, C.B.E., Chairman of Scottish Omnibuses has been elected President of The Institute of Transport for 1961-62.

R.A.C. HANDBOOK

The 1961 edition of the Royal Automobile Club's Guide and Handbook, with some justification, claims to be the world's most comprehensive encyclopaedia. This year's edition contains the record number of one million words and covers a wider field than ever. In addition to the directory of 4,500 R.A.C. Appointed and Approved Hotels and 8,000 R.A.C. Appointed garages in Great Britain and Ireland, there are several hundred pages containing essential information for the motorist and motor cyclist. These include the Highway Code, motor laws, hints on motorway driving, traffic signs, foreign touring, registration and licensing, car-by-train and steamer services, ferries, hills and their gradients, airports, motor racing circuits, lighting-up times, R.A.C. telephone boxes, and many more.

The Handbook is available for members at all R.A.C. Offices at 8s. 6d. post free. To non-members the charge is 12s. 6d.

EASTBOURNE'S FIVE YEAR PLAN 1958 - 1963

Fig. 1. Old and new columns and lanterns.

by B. C. OSSITT *M.A.P.L.E., Dip. M.E.S.*

Mr. Ossitt, of the South Eastern Electricity Board, gave a paper entitled 'The Relighting of a County Borough 1958-1963' before the Association of Public Lighting Engineers (London and South Eastern Section) recently, and extracts are printed below.

THE County Borough of Eastbourne was, according to the accepted standard of street lighting in 1938-39, a very well lighted town and indeed was justly proud of such fame. The basic fundamentals were that the mounting height on main roads should be of the order of 25 ft.; the spacing of the order of 150 ft. For side roads the mounting height be of the order of 15 ft. and the spacing generally 120 ft.—so far for the well accepted principles. Provided that a light source of sufficient lumen output was used and the road surface was kind to the installation, then one could anticipate, generally speaking, a good and well lit road according to the recognized standard of that day. One further main principle was supplied in Eastbourne which still exists today, and no doubt will be continued for many years to come, and that was that the main traffic roads into the town centre should be lit by sodium lighting and the town centre itself, where it was believed that some form of colour correction was essential, should be lighted by a form of colour corrected mercury lamp. In fact, these were 400 or 250 watt mercury lamps housed in large decorative lanterns in which there were also three 100 watt tungsten filament lamps. These gave some colour correction and indeed did their job very well.

As a result of advice from the S.E. Electricity Board during the early and middle 1950's, improvements to the street lighting installations were made. Such were generally a change of lanterns, a repositioning of light sources and other matters of a general minor nature, the costs being met out of the rate revenue. There was, of course, great building activity within the town and the Corporation very early on accepted the advice of Seeboard and adopted the principle of a strict adherence to a Group B standard of lighting on all public and private housing estates.

For some time the Corporation, on the advice of Seeboard, had been replacing lanterns which had been in commission for some twenty years and were generally in a poor state of repair. The old sodium lanterns were part of the original installation installed in 1938 and were generally of the open reflector type. When examined, the reflectors had completely disintegrated, due mainly to the corrosive action of sea air. These lanterns were replaced by a totally enclosed lantern chosen after various tests for its general efficiency and in particular for its robustness and resistance to corrosive elements. The large decorative lanterns in the town centre, using the combination of mercury and tungsten lamps, were generally in fair condition and the recommendation was that, starting from the outside of the town centre inwards, they gradually be replaced by a modern refractor lantern. Many of the old lanterns, however, were still good for a few more years of service and so the mercury and tungsten lamps were taken out and in general a 400 watt M.B.F.U. mercury lamp replaced the four mixed mercury and tungsten lamps. In the course of the next year or so it is hoped that all these lanterns will be changed over to a modern refractor type and the standard of lighting generally will be greatly improved, due purely to the lighting control obtained from the modern lantern as opposed to the entire absence of light control in the original.

It may be that a greater improvement can be made on parts of the original sodium installation as it has been found that it will be comparatively simple to obtain a 30 ft. mounting height on the columns already in situ. It may be that it will be decided to install 200 watt sodium lamps in this particular area. This will not seem out of place as the particular stretch of road under review lies between a 400 watt colour corrected mercury stretch and a new 140 watt sodium stretch which has a maximum of 120 ft. spacing. It is therefore anticipated that if 200 watt sodium lamps are used at 30 ft. mounting height, leaving the original spacing of 150 ft., then broadly speaking the standard of lighting throughout will be approximately the same, which is the thing that matters.

In the meantime certain original street lighting experiments had been evolved and carried out by Seeboard with the collaboration of the Corporation. Notably amongst these was the original fluorescent wall mounting installation in South Street, and the vertical fluorescent installation in Devonshire Place. In 1957 the Corporation were advised to try an installation of the rapidly developing colour corrected mercury lamp. The road selected was one which was part of a short cut from the station to the main hotel area on the Promenades, so College Road was equipped to a generous Group B standard with 125 watt M.B.F.U lamps in G.E.C. Dagenham lanterns. This installation provoked considerable interest and, as with many other small things, larger issues developed, so a Sub-Committee was appointed to examine, consider and make a report on the street lighting installation in the town. This Sub-Committee consisting of the Borough Engineer, Mr. R. Williams, the Chief Constable, Mr. R. W. Walker, and the District Manager of Seeboard, Mr. J. Winborne, were instructed to consider and report back to the Highways and Drainage Com-

TEC517 *for further information*

REVO

lighting goes to the front

Photo by kind permission of C. Anderson, M.I.E.E., M.Inst.F., Borough Electrical Engineer and Manager, Douglas Coporation Electrical Dept.

The impressive two mile long sweep of Douglas, Isle of Man promenade is shown here brilliantly illuminated by Revo Helion lanterns (shown top left) specially developed for this scheme.

Lighting the promenade of a seaside resort involves a number of problems not usually encountered in normal street lighting. The road surface must be exceptionally well illuminated especially during the holiday period. True colour representation is most important. A bright spectacle must be provided without detracting from the effect of other purely decorative lighting. The lanterns must be decorative both when lighted and during daylight and must withstand the effects of storms and sea spray. During the winter provision for the reduction of the lighting to normal standards must be made. All these conditions have been satisfied by the Revo installation at Douglas and has received widespread approval from residents and visitors.

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TIPTON, STAFFORDSHIRE

W & W

mittee of the Eastbourne Corporation any improvements or suggestions on anything which they thought necessary to the installation. Having made a survey of the town and taken expert and 'inexpert' opinion on street lighting matters generally, they in due course presented a report which made recommendations for improvements to the street lighting throughout the Borough over an initial period of five years. This report was eventually approved by the Corporation and put into effect. Generally speaking, the Corporation recommended that the product of a 1d. rate (approximately £5,000) should be spent in each of five years on improving street lighting.

Priority for the Promenades

The first year of real progress was April to March 1958/59. The first major scheme of improvement to be tackled was on the Promenades (which on account of cost was split into two halves and carried out in successive years). The original installation consisted for the most part of 300 watt tungsten lamps in opal globes mounted at a height of 16 ft. on cast iron columns. This was supplemented by a series of widely spaced ornamental lanterns on cast iron columns and each had a 500 watt tungsten lamp. All were substituted by the installation of a specially designed post top lantern equipped with a 250 watt M.B.F.U. lamp. There was no room to accommodate the ancillary gear in the base of the column so it was housed in the bottom of the lantern. The resultant illumination was so good that the old highly ornamental cast iron columns which carried the 500 watt lamps were felled and there is no street furniture now other than 16 ft. lamp columns to obstruct the view. This installation has been in commission for over two years and there has not been a really serious accident on the Promenades during the hours of darkness in that period.

In 1958/59 the second improvement was the busy Meads Road leading from the town westwards to a select residential area. It was decided, for this installation that colour corrected mercury lamps should be used and installed, 25 ft. mounting height, 120 ft. maximum spacing using 250 watt M.B.F.U. mercury lamps and the result was probably, at the time, the best main road lighting in the town.

Fig. 2. The Promenade looking from east to west by day.

In the financial year 1959/60, the Promenades installation was completed, but at the eastern end of the town there was a minor road which was regularly used by incoming and outgoing traffic to get to the Promenades. The existing lighting was by 100 watt tungsten filament lamps in refractor lanterns, the spacing being rather wide for a reasonable Group B installation. The lighting of Channel View Road, therefore, was redesigned and five additional lighting points were added to the existing resited columns. The light source was changed to 125 watt colour corrected mercury lamps, making a generously planned Group B installation. This was a minor job but it provided a well lit connecting road between the main approach road on the east of the town to the nearest point for access to the newly lit Promenades. The advantage of improved lighting on this road was quickly appreciated and new direction signs were erected to direct traffic along it, thus intending to cut out the use of many of the side roads leading to and from the Promenades which, with their many crossings, had previously been the scenes of some serious and other minor accidents.

The third major scheme during this year was the relighting of part of an important bus route from the centre of the town to the residential area of Hampden Park to the north. Traffic leaving the town went through a Group A sodium installation then turned into a reasonable Group B installation and finally rejoined the Group A sodium installation. The whole of the Group B installation was therefore changed over to a first class sodium Group A installation using 140 watt sodium lamps in Revo lanterns. During the 1959/60 financial year the total sum expended was just short of £5,000.

Three Years Progress

The programme for 1960/61 included a major scheme along four roads leading to the rapidly developing industrial site at Hampden Park to the north of the town. The existing lighting was again of a Group B standard using 100 watt lamps on 15 ft. columns. It has now been changed over to a Group A installation, some 50 140 watt sodium lamps. A major secondary scheme during the year was the relighting of the eastern portion of South Street from the termination of the original wall mounting installation to Memorial Square—the original lighting being a somewhat diverse selection of 15 ft. and 20 ft. columns with 300 watt tungsten lamps in a variety of lanterns, generally speaking not a very good installation. However, this was completely redesigned and is now a thoroughly up-to-date Group A installation using 250 watt colour corrected mercury lamps because this portion of South Street is essentially a shopping area. This new lighting has unfortunately somewhat dimmed the installation along the western end of South Street, i.e. the original wall mounted installation. This installation is still using the original prototype single tube lanterns made specially for the job and there is no doubt that in the near future these will have to be replaced with the modern version of this wall mounted lantern, where each lantern is fitted with two 5 ft. fluorescent tubes: this will then give an equality of street lighting with the newly completed eastern end of South Street.

By March, 1961, three years of the five-year plan had been finished and seven major lighting schemes have been installed at a total cost just in excess of £15,000, all paid for out of revenue.

Fig. 3. The Promenade by night.

Fig. 1. The Bull Ring Centre, Birmingham, looking towards New Street and the High Street from beneath Ringway Bridge over the Inner Ring Road.

Birmingham

BULL RING SHOPPING CENTRE

BIRMINGHAM's traditional marketing and trading area, the Bull Ring, is to be the site of a £5 million project for the creation of a multi-level shopping and commercial centre which, it is claimed, will be the most advanced trading centre in Europe. The centre is to occupy three sites on both sides of the Inner Ring Road, interlinked by covered bridges which will incorporate shops. The total site area is some four acres in extent, lying between St. Martin's Church and the reconstructed New Street Railway Station, with which it will be directly linked by a covered shopping mall. Some 15 entrances will be provided: from the railway station, the bus station and the Inner Ring Road. Escalators capable of handling 28,000 persons an hour will be provided.

Incorporated within the Centre there will be 350,000 square feet of retail shopping space in 140 shopping units, department stores, supermarkets, a general retail market covering an area of 36,000 square feet and a separate fish market of 14,000 square feet. There will also be restaurants and coffee bars, licensed premises, banks, a baby crèche and pram park, multi-storey car park, a new central bus station and a seven-storey office and management block. Facilities for entertainment and recreation will be included in the scheme.

Laing Development Co. Ltd. is responsible for the project; the contractors are John Laing Construction Co. Ltd., and the architects are S. Greenwood, A.R.I.B.A. in association with T. J. Hirst, A.R.I.B.A., A.M.T.P.I. Work began on the site last month and the whole is planned for completion by the end of 1963.

The bus station and market level will comprise:

(*a*) Midland Red Central Bus Station with 32 standing places.
(*b*) Service area including loading bays and lifts for the department store block on the west side of the Inner Ring Road.
(*c*) The fish and general retail markets.
(*d*) Sales floor of F. W. Woolworth & Co. Ltd.
(*e*) Shops, banks, public houses, etc., fronting East Court and Edgbaston Street.

There will be four escalators, two at the market entrance and two in the foyer between the bus station and market areas, which give access to the shopping floor above.

The first shopping floor will have direct access by subway from New Street and from the footpath on the south side of the Inner Ring Road and also by staircase from the West Court. It will also be approached by escalators from the foyer adjoining the bus station and the market entrance, and by spiral ramp from the East Court. In addition to the sales floor of F. W. Woolworth and Co. Ltd. and the Midland Red Bus Company's snack bar, there will be 36 shop units and the lower level of the three-level department store. At the western end of this floor the Central Court will be situated, which in addition to providing a focal point for the centre, will also be used for trade shows and exhibitions. Four escalators will rise from this court to the upper shopping level.

Concluded on page 126.

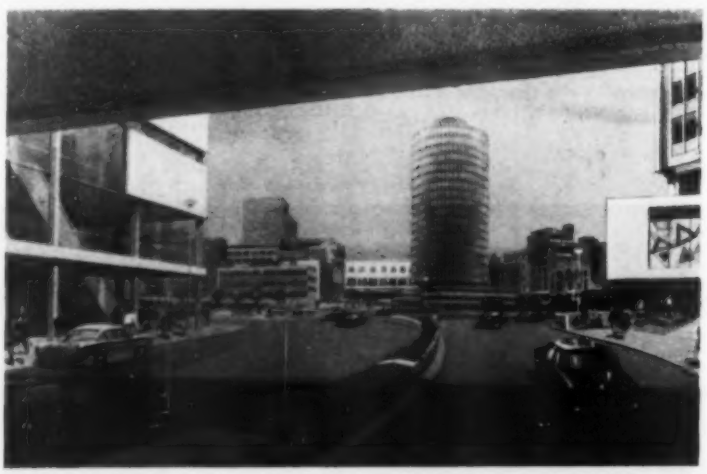


Fig. 2. General perspective of the Bull Ring Centre with the department store and building in the right background connected by bridge over the Inner Ring Road with the main shopping centre. The rectangular four level multi-storey garage is to the left.
A further illustration is on page 104.

Woolwich's Automatic Garage

Fig. 1. The mechanical equipment in the Autostacker multi-storey garage at Woolwich.

THE Metropolitan Borough of Woolwich, the second largest of the metropolitan boroughs, with a population of 145,000, is the first local authority to own an 'Auto-stacker'—and this is believed to be the first fully automatic garage to be completed in the country. It was opened by Princess Margaret on May 11.

The council's decision to build the Autostacker is part of its wider plan for solving the traffic problems of the borough which extends on both banks of the Thames and which includes docks and the Royal Artillery garrison within its area. The plan involves the control of short-term parking and adequate provision off the streets for motorists who wish to park all day.

It was decided that the solution to the problem of short-term parking would best be met by the introduction of parking meters of the type already in use in central London and in Bristol Unlike other authorities, however, Woolwich also decided that the introduction of parking meters must coincide with the provision of an adequate amount of off-street parking at rates commensurate with the motorists' means to pay.

For this reason it was decided to develop a site fronting on Beresford Street for the erection of two multi-storey garages, each with the requirements of the long-term parker primarily in mind. The first of these two garages, the Autostacker, has now been built giving accommodation for 256 cars, and a further 50 cars at ground level, on the site reserved for the second garage. The building also contains a car showroom, servicing facilities and a petrol filling station. With the completion of a second garage, there will be accommodation for a total of 512 cars on the Beresford Street site.

Soon after the contract for the Autostacker was placed, the council purchased an open site in Woolwich New Road at the southern end of the meter zone, which has now been laid out as a surface car park capable of accommodating 350 vehicles. The council has also two smaller parking places which, in total, will take a further 50 cars. When, therefore, the meter scheme was brought into operation on May 15, there were available, within the controlled zone, some 650 parking places off the highway for the all-day parker, and a further 360 kerbside spaces at the parking meter bays, making a grand total of just over 1,000 places for motorists to park in the town centre at any one time. Charges are being made at the surface car parks comparable to those being made at the Autostacker.

A careful assessment of requirements was made at the time, when the parking meter scheme was first promoted, when it was calculated that these facilities would be more than sufficient to meet the present day requirements of both the businessman wishing to leave his car all day, and also the shopper or visitor who needs to stay for a comparatively short time. The council realizing that the motorist population is increasing daily has other schemes in hand which, when they materialize in about two or three years' time, should provide an additional 600 parking spaces off the highway.

The decision to build an Autostacker was taken after considering designs for many different types of multi-storey garages and their relative costs. The Autostacker was chosen because it is fully automatic, needs a minimum of staff to operate it, and requires a comparatively small site.

The council has also decided to lease the garage to Shell-Mex and B.P. Ltd., who in turn have sub-let it to Dagenham Motors Ltd., who will operate the garage and service station on conditions agreed with the council. Possibly the most significant feature of this arrangement is the fact that the all-day charge has been kept to the very low figure of 2s. 6d., which cannot be increased without the council's consent.

The main contractors for the Woolwich project, and exclusive licensees of the system, are Auto-Stackers Ltd. who are associated with John Brown & Co. Ltd., and Standard Telephones & Cables Ltd. Mr. Stirling, a director of J. A. Stirling Ltd., civil engineering contractors, is consultant to the company and a member of the Board.

The eight floors of the Woolwich Autostacker accommodate 256 cars. Four lifts are incorporated, each catering for 64 vehicles. With maximum and minimum operating cycles of 23 and 75 seconds respectively, the average time for parking or collecting a car is 50 seconds per lift, and on this basis, the Autostacker when fully occupied can be cleared in about 55 minutes. Compared with a four-storey drive-in type of ramp garage, the Autostacker can accommodate between 75 per cent and 100 per cent more cars in a building of similar dimensions. The system is extremely flexible and can utilize much smaller or more awkward sites that those required for more conventional methods.

The Autostacker is divided into three equal galleries running the length of the building. The two outer galleries are separated into vertical parking levels, each divided into 16 parking spaces, 17 ft. 6 in. long by 6 ft. 8 in. wide. The central gallery is clear and contains four lifts, one at each end and two in the centre, and the rails for the powered transporters at each parking level.

The car is driven on to one of the eight loading conveyors placed on either side of the hoists. The parking operation is initiated by the attendant in the control kiosk and the car moves forward on to a transporter standing on the hoist. This transporter also supports twin conveyors. The hoist rises to the selected floor: the transporter then leaves the hoist and travels along the central gallery to the chosen parking

Fig. 2. Exterior view of the Autostacker garage.

slot. At this stage the conveyors on the transporter propel the car into the preselected slot, whereupon the slot conveyors complete the parking operation. The rear wheels of the car are always nearest the gallery. The transporter will then follow one of two programmes: it may return to the hoist at ground level or proceed direct to a collection cycle for a required car.

The mechanical equipment is operated in accordance with electrical signals transmitted from a central control unit. The unit is essentially a series of relays and sequence interlocks which ensure that each succeeding operation will take place only after preceding events have correctly occurred.

The principle of operation is quite straightforward and involves the adoption of recognized electrical and mechanical practices that have been accepted in industry for a long time. It is the manner in which these practices have been applied, rather than the introduction of any new mechanical process, that has made this new form of automatic parking possible.

A full day's parking costs only 2s. 6d., and a car may be parked for up to four hours for 1s. 6d. These charges may not be varied without the consent of the Woolwich Council, and it is their intention to stabilize charges at this figure for as long as possible.

The motorist parking at the Autostacker drives his car just inside any entrance bay which shows a green light indicating that a hoist is available. A control light will show that he has correctly parked his car on the loading platform. He then puts on his handbrake and leaves the car, locked if he wishes. At the control kiosk, he is given the appropriate key withdrawn from the control panel. The key is the 'receipt' for his car. When the key is withdrawn from the panel, the car is automatically placed in the parking slot for which the key has been taken. When he wants his car, the motorist gives his key to the attendant who returns it to its place in the control panel. This automatically starts the machinery that will deliver the car to the motorist within seconds.

Bull Ring—*concluded from page* 124

All trading accommodation will be contained within the covered main structure of the Centre in which the temperature will be regulated in public thoroughfares and separate precincts, while each shop will have a separate control unit. Air conditioning and cooling plant will maintain an equable temperature throughout the year. The planning of the public malls and courtyards is arranged to afford the advantages of a first-class shopping street—under ideal climatic conditions and free of the hazards of traffic congestion.

The basement level is approached by ramp from Edgbaston Street, and will contain loading bays and service lifts for goods delivery to the whole of the main block of the scheme; storage areas for the fish market and general retail market, together with certain shop storage areas, stock rooms, strong rooms, refrigeration plant and boiler house.

At the car park level, at the western end, the West Court will be situated, which will have on its perimeter seven shop units and the middle level of the three-level department store. An escalator will be located at the entrance from this court, giving access to the upper shopping level. Also on this floor is the entrance and assembly area for the multi-level car park and a large portion of the Woolworth store.

Access to the upper shopping level will be by escalators from the High Street/New Street entrance, by escalator from the West Court and via the bridge over the Inner Ring Road by means of the covered mall leading from New Street Station. The four escalators positioned in the Central Court provide a direct link between the two shopping levels. On this level, in addition to storage areas over the West Court shops, there will be 40 shop units, the upper level of the three-level department store—and on the bridge leading from the High Street/New Street entrance, either a large store or supermarket unit. At this level there will be entrances to the large Woolworth store.

Below the store or supermarket unit, and to the north of the south carriageway of the Inner Ring Road, at the level of the new open market, there will be two kiosk shops and refreshment facilities and foyers etc., serving a bowling centre, which it is proposed shall be built below the public gardens. On the floor above this and below the bridge level, a restaurant is planned but it may be that this section will be incorporated with the supermarket area for use as a small department store. Above the roof level of the main block there will be the seven-storey office and management building and a four-level car park for 500 cars. Exit and entrance to the car park will be from the Inner Ring Road and it will be equipped with car lifts.

At the Inner Ring Road level there will be the main floor of the department store, together with five shop units fronting the Inner Ring Road. The first floor level will contain the first floor of the department store, together with 10 shop units fronting an air-conditioned mall, access to which will be by escalators from the Inner Ring Road and the covered mall leading to New Street Station. At the second floor level, a bridge will connect the department store block with the main block and there will be 23 shop units fronting the mall, together with a large supermarket, and the entrance to the banqueting suites which will be situated at the level above and are planned to cater for up to 2,000 persons. Access to this level will be from the covered mall leading from New Street Station, escalators from the Inner Ring Road, and escalators linking with the upper shopping level of the main block. At the eastern end of the bridge and below the office block, the baby crèche and pram park will be situated.

CORRECTION

In the article on 'Case for Urban Motorways' by Wilfrid Andrews in the May issue, Professor W. Fisher Cassie is reported as saying 'If one-fifth of the total mileage of a community's roads is an urban motorway, it can carry 50 per cent of the total traffic'. The quotation should have read 'If five per cent of the total mileage of a community's roads is an urban motorway, it can carry 50 per cent of the total traffic.'

Bibliography of Traffic Engineering

Inadvertently in the Bibliography of Traffic Engineering published in the March, April and May issues, sections on Parking Economics and Planning were omitted. These are given below, together with a list of journals covering the field. This addendum will be incorporated in the publication of the Bibliography in pamphlet form.

IX PARKING

1. **Memorandum on parking places.**
   Ministry of Transport. *Memorandum* No. 597. H.M.S.O., London, 1946.
2. **Report of the working party on car parking in the Inner Area of London.**
   Ministry of Transport. H.M.S.O., London, 1953.
3. **Parking survey of Inner London.**
   Interim report, September, 1950. Ministry of Transport and Civil Aviation. H.M.S.O. London, 1956.
4. **Parking survey of Inner London.**
   Final report, November, 1957. Ministry of Transport and Civil Aviation. H.M.S.O., London, 1958.
5. **Parking manual.**
   American Automobile Association, Traffic Engineering and Safety Department. Washington, D.C., 1956.
6. **Parking.**
   R. H. Burrage and E. G. Mogren. Eno Foundation, Saugatuck, 1957.
7. **Traffic design of parking garages.** E. R. Ricker. Eno Foundation, Saugatuck, 1957.
8. **Off-street parking.**
   H. E. Meacock. *J. Instn. Highw. Engrs.*, 1958, **5**(4), 267-86; Discussion, 287-94.
9. **Multi-storey parking garages.**
   E. G. Kitchin. *Trussed Concrete Review No.* 19. Trussed Concrete Steel Co. Ltd., London, 1957.
10. **Parking meters—a study of their numbers, revenue and use.**
    D. R. Levin. Highway Research Board *Bulletin* No. 81. Washington, D.C., 1954.
11. **The parking meters (description and testing) (England and Wales) Order, 1957.**
    Minister of Transport and Civil Aviation. S.I. No. 822 H.M.S.O., London, 1957.
12. **London traffic. The parking places (Westminster) (No. 1) Order, 1958.**
    Minister of Transport and Civil Aviation. S.I. No. 549 H.M.S.O., London, 1958.

X. ECONOMICS

1. **The economic assessment of returns from road works.**
   G. Charlesworth and J. L. Paisley, *Proc. Instn. Civ. Engrs.*, 1959, **14**(Nov.), 229-54.
2. **The cost of road accidents.**
   D. J. Reynolds, *J. Roy. Statists. Soc.*, Series A (General), 1956, **119**(4), 393-408.
3. **The economics of inland transport.**
   A. M. Milne. Isaac Pitman & Sons Ltd., London, 1960 (Revised edition).
4. **Highway economics.**
   G. J. Ponsonby, *J. Instn. Highw. Engrs.*, 1952, **2**(7), 7-13; Discussion, 14-28.
5. **Economics of road improvement.**
   D. J. Reynolds, *J. Instn. Munic. Engrs.*, 1959, **86**(1), 9-14.
6. **Road Accidents—a report submitted to the Minister of Transport.**
   J. H. Jones. London, H.M.S.O., 1946.

XI. PLANNING

1. **Advisory handbook on the redevelopment of central areas.**
   Ministry of Town and Country Planning, H.M.S.O., London, 1947.
2. **Urban motorways.**
   British Road Federation, London, 1955.
3. **Shopping centres.**
   Locating controlled regional centres. Eno Foundation, Saugatuck, 1956.
4. **The London-Birmingham Motorway—Traffic and Economics.**
   Part I. Traffic investigation. T. M. Coburn. Part II. Economic assessment. M. E. Beesley and D. J. Reynolds. Department of Scientific and Industrial Research, Road Research. Technical Paper No. 46. H.M.S.O., London, 1960.

XVI. JOURNALS

1. **Proceedings of the Institution of Civil Engineers.**
   London.
2. **Journal of the Institution of Highway Engineers.**
   London.
3. **Journal of the Institution of Municipal Engineers.**
   London.
4. **Journal of the Town Planning Institute.**
   London.
5. **Highways and Bridges and Engineering Works.**
   Ashford.
6. **Roads and Road Construction.**
   London.
7. **International Road Traffic and Safety Review.**
   London.
8. **Traffic Engineering, Institute of Traffic Engineers.**
   Washington, D.C.
9. **Traffic Quarterly.**
   Eno Foundation, Saugatuck.
10. **Traffic Engineering and Control.**
    London.

Traffic Symposium

(*Concluded from page* 107).

view when I think of the work that has been done in this country since the war. Where we have, in the traditional manner, entrusted streets to one profession and buildings to another (as in much of the blitzed city reconstruction) the results have not been impressive. Where (as for example at Stevenage and still more so at Cumbernauld) we have adopted the comprehensive architectural approach then a real advance is apparent in the handling of traffic.

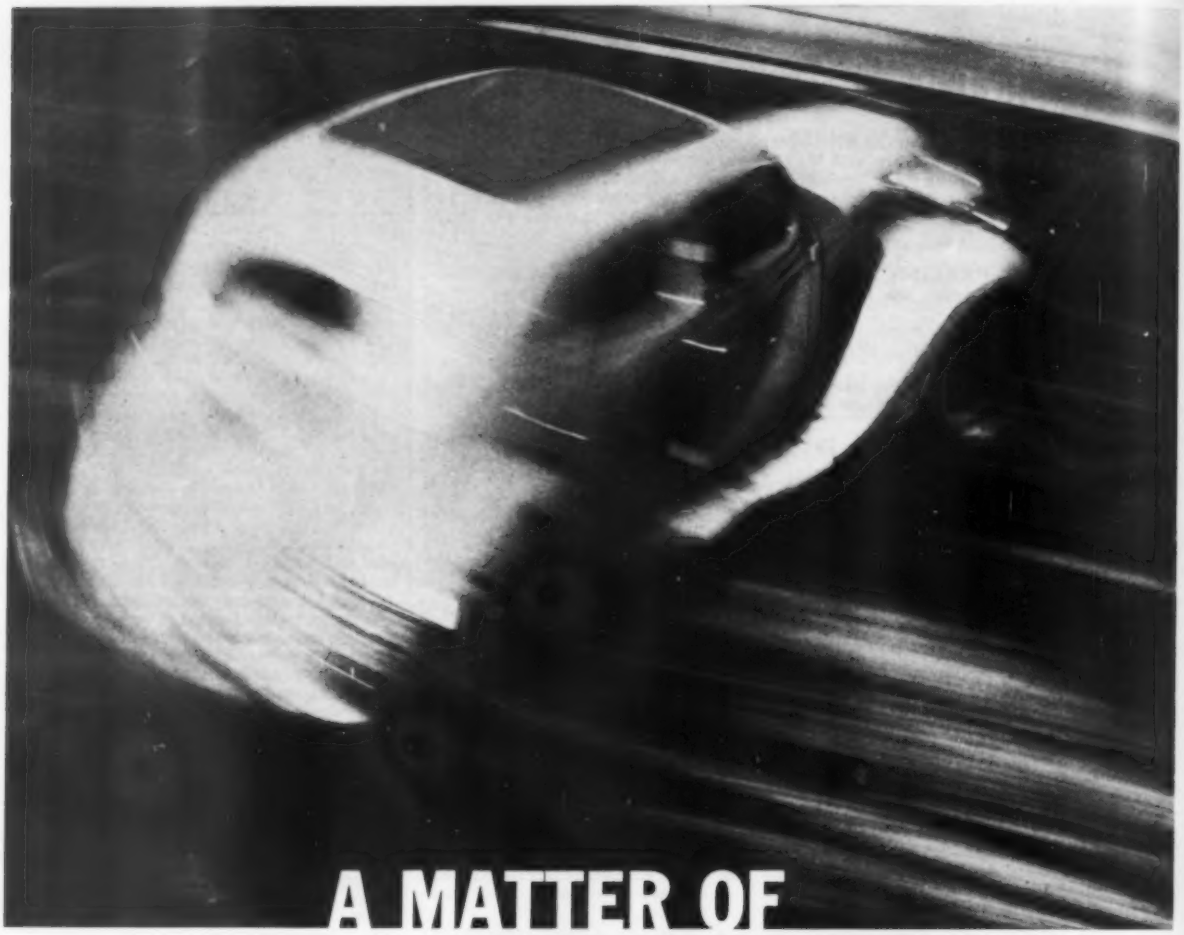
Thus far, I have been primarily concerned with circulation and I have endeavoured to show that the multifarious uses, to which the motor vehicle is now being put, pose a complex problem of circulation in relation to buildings which is closely akin to a problem in architectural design. If I am right in this, then important consequences follow because a new and extremely powerful influence is brought to bear on architectural form. This new means of getting around has put the traditional arrangements of streets and buildings completely out of date. New arrangements are needed if we want to use this machine to the best advantage. It is not a matter of a few new roads, bigger and better intersections and more car parks, it is a matter of a new environment on a big scale, and this of course means reconstruction on a big scale. It may be objected that it is fantastic to think of the complete rebuilding of all towns, but I am not really concerned with this. All I am saying is that, if we want to exploit the motor vehicle, very extensive and very expensive alterations will be required to towns. To the extent that we do not make such alterations through inability to see the matter clearly, or lack of courage perhaps, or the sheer difficulty of the associated problems of finance and estate management, or (as is bound to happen in many instances) a positive desire not to alter the character of some much-loved and admired locality, so we shall be setting a long-term inhibition on getting the most out of the motor. But one thing should be remembered, and that is that large areas of many, if not most towns will be coming up for renewal in the ordinary course of events, and if we can take hold of these areas and re-shape them comprehensively then the opportunities will be very considerable.

The paper presented by Mr. C. F. Duff on Traffic Designs in Urban Areas will be published in the July issue of Traffic Engineering & Control.

Traffic Symposium

The papers, and discussions that followed their presentation to the Symposium on Urban Survival and Traffic held at King's College, Newcastle upon Tyne, University of Durham, April 10-14, 1961, will be published in full in the Volume of Proceedings which is now in preparation and will be published later this year by E. & F. N. Spon Ltd.

I.C.I. gratefully acknowledges the assistance given in the interests of road safety by Galliford and Sons Ltd., highway contractors and promoters of Anti-Skid Schools Ltd., Wolvey, Hinckley, Leicestershire, where this photograph was taken.



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BS. 169

INDUSTRIAL NEWS and INFORMATION

AT the International Construction Equipment Exhibition at Crystal Palace in June, Millar's Machinery Co. Ltd. will be displaying the following items amongst those on their stand.

3½-T Fast Towing Concrete Mixer. This company's well-known 3½ cu. ft. tilting drum, hand fed machine is now available as a fast towing unit with a telescopic drawbar which operates brakes automatically. On site the drawbar pushes beneath the machine, completely out of the way, and it is a simple matter to withdraw the bar, turn it to engage the brake overrun device and connect up to the towing vehicle. A safety bar is fitted to the drawbar making it impossible to link to a towing vehicle without engaging the brake mechanism. The machine has been designed so that it is a simple matter to convert customers existing 3½-T machines to fast towing units, and conversion kits are available to do this. A 5 cu. ft. capacity machine similar in design to the 3½-T machine will also be exhibited for the first time as a fast towing model.

14-RH Reversing Drum Concrete Mixer. This machine, jointly manufactured by Babcock and Wilcox Ltd. and Millars' Machinery Co. Ltd. is a 14 cu. ft. mixed batch capacity machine. It is a fast mixing machine with an exclusive triple cone mixing drum, hydraulically operated loader bucket, batch weighing equipment, precision control of water feed and grouped controls. Discharge is by simple reversal of the drum.

Millars Vacuum Press. A unique machine for the fast production of concrete slabs. By using the vacuum process method pioneered by Millars, this compact machine produces a concrete slab up to 3 ft. x 2 ft. x 2 in. thick in approximately three minutes. The low cost of the equipment, plus speed, simplicity of operation and minimum maintenance, keeps down the price per unit even on the shortest run. The unit occupies only 9 sq. ft. and is 10 ft. high. This exhibit is a completely new piece of equipment for contractors.

T.E.C. 199 for further details

Rapier 1520 Mobile Crane

At the same exhibition, Ransomes and Rapier Ltd. will show a truck mixer, a self-priming pump and their 1520 mobile crane.

The 1520 crane, which is new to the Rapier range, is to be displayed with a 60 ft. strut jib. However, cantilever jibs are also available and both types are extendable. The basic length of the former is 30 ft., extendable by 10 ft. and/or 20 ft. lengths to give a total of 80 ft. The cantilever jibs are made in basic lengths of 20 ft. and 30 ft. and bolt-on extensions are available to give a total length of 50 ft. All controls for travel, hoist, derrick and slew are situated in the driver's cab. The drive is diesel-electric with separate motors for each operation. Air-assisted power steering gives good manoeuvrability, a turning circle of 21 ft. 6 in. on the inner wheel, and travel brakes on all wheels are also power assisted.

Slewing is on a pre-loaded, cross-roll bearing, which requires no maintenance except occasional lubrication. The setting of the roller bearings forms a cone between upper and lower rolling sections of the slewing ring, above the horizontal centre and coinciding with the centre line of rotation.

T.E.C. 200 for further details

Please use the prepaid cards for the Reader Information Service. For further details of items mentioned in this journal, complete and return the card to us.

Direct Coupled Pump

Amongst other items of equipment, Bamfords Ltd. will be showing a pump unit, with a capacity of 30,000 gallons per hour, on their stand at the Crystal Palace. This set comprises a 4 in. Lee-Howl centrifugal pump directly coupled to a Bamford's A.C.1. single cylinder air-cooled engine and mounted either on a fabricated base or two wheeled trolley, whichever is required. The details of the pump are below.

Impeller: machined cast iron, single suction enclosed type, designed to eliminate end thrust. It is mounted on an extension from the engine crankshaft.

Headstock base: a special design in high grade cast iron with an open top to allow access to the gland and the free entry of air to the engine fan. Accurately machined spigots ensure alignment of pump and engine.

Shaft: machined high tensile steel, flanged and spigotted at one end to register accurately on the flywheel hub and keyed at the other end for the impeller.

Stuffing box: an efficient gland seal is obtained by supplying water under pressure from the pump discharge through an internal passage to a lantern ring with packing at each side.

Suction and delivery flanges: 4 in. drilled flanges in accordance with British Standard Table D. The delivery flange can be arranged either vertically or horizontally.

Trolley: a two-wheeled fabricated trolley, with cushion tyres.

T.E.C. 201 for further details

Dump Trailer

The introduction of a new, robust, highly manoeuvrable dump trailer for short fast hauls, or to double-up capacity on level sites, is announced by Thwaites Engineering Co. Ltd. The trailer is designed to carry 1¼ cu. yd. of material over rough terrain, and instant discharge is available. It is mounted on

Thwaites new dump trailer.

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Whenever crowds gather in busy thoroughfares, the risk of accident is increased. There's no road sign like this to warn motorists of the danger. That's why it pays to erect safety barriers, to keep pedestrians off the road and speed the flow of traffic through congested streets.

FOR EVERYDAY USE—FOR THE BIG OCCASION

When road construction work is going on, use safety barriers to surround the site and divert traffic. Line the pavements outside schools with barriers, to prevent children dashing out into the road. At street parades, pageants, premieres and mass meetings, erect barriers to clear the way for traffic and keep spectators out of harm's way. At sporting events, place barriers along the approaches to stadia, to channel motorists and pedestrians into separate streams. Barriers can also be used to form temporary car parks.

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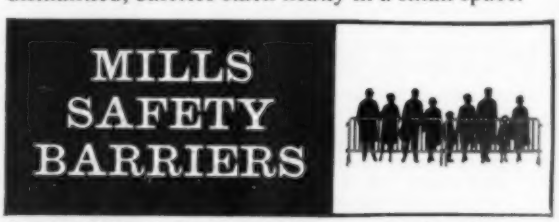

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wide track 650 x 16, 8-ply pneumatic tyres and is suitable for road and site use. Loading height is 48 in. with a maximum skip capacity of 30 cwt. The trailer is well balanced with low centre of gravity, and of robust construction with box channel, steel section frame and ¼ in. mild steel plate skip, suitably reinforced at the lips. Brakes, if required, can be supplied as an optional extra.

T.E.C. 202 for further details

Heating Car Park Ramps

A multi-storey car park in Cardiff was designed with external ramps with a gradient of 1 in 11, and these would be prone to icing up in frosty weather. The ramps are of monolithic construction, and normal methods of installing road heating cable could not, therefore, be applied. However, Thermodare (Great Britain) has now provided a cable and a method of installation which overcame these problems. Working from a duct fixed at the mid-point of each ramp, heating cable was attached to the reinforcing rods at approximately 18 in. centres, the cable runs being 4½ in. apart. Concrete was then poured in the normal manner leaving the cable at the proper level.

The loading for each of the eight ramps from ground to fourth floor level is 10.30 kW., giving a density of approximately 12 watts per square foot of ramp area. For the two ramps from fourth floor to roof level, this loading was increased to 15.20 kW. per ramp, giving a density of approximately 17½ watts per square foot. These loadings are necessarily higher than is found suitable for normal road frost protection installations, owing to the proportion of heat which is transmitted to the underneath of the ramps. Provision for cable maintenance is through the central duct. The resistance element in the heating cable is loosely contained in the P.V.C. insulating sheath, so that lengths may be replaced at any time with minimum interference to the surface of the ramp. Control of the installation is by air and fabric temperature thermostats operating in parallel, providing protection both against air frost and surface icing.

T.E.C. 203 for further details

Motor Tunnel Tenders

Selected contractors from Britain, France, Holland and U.S.A. are now being invited by the Hong Kong Government to tender for the construction of a mile-long tunnel through the Kowloon Hills. Cutting is scheduled to take two years and will cost about £343,750.

Originally it was conceived that the tunnel would carry water pipes as part of the distribution system of the £40 million Plover Cove project to improve the Colony's water supply. However the opportunity has been taken of combining with the scheme a much needed way through for vehicular traffic, and the tunnel will now contain a 24 ft. two-lane carriageway and three or four large water mains.

T.E.C. 204 for further details

Joint-Bond Test Apparatus

A joint extension machine for testing the strength of bonds formed by concrete pavement joint sealers is now available from Soiltest, Inc., Chicago. The apparatus is a product control device designed for use by highway departments, airport authorities, testing laboratories, military engineers and sealant producers. The machine is suggested for use in testing sealers of plastic and bituminous materials which are designed for pavement joint use. The design and operation of the joint-bond apparatus is in accordance with federal specifications, Corps of Engineers requirements and with the procedure of the American Society for Testing Materials D-1191-52T.

In the test, small cement mortar blocks 1 in. x 2 in. x 3 in. are bonded with the sealer. The operation of the testing machine simulates the expansion of a pavement joint. The cement blocks are pulled apart at the rate of ¼ in. per hour. Test specifications for sealers require that they must not elongate or lose bond past a certain number of inches (normally ¼ or ½ in. per 2- or 4-hour period). The machine may be run at temperatures as low as—20°F.

T.E.C. 205 for further details

John Deere-Lanz 1010

The John Deere-Lanz 1010 crawler loader made its first public appearance recently at a working demonstration near Windsor. Demonstrated at the same time was the John Deere-Lanz No. 51 backhoe attachment.

On topsoil stripping the machine showed its ability to load quickly, moving rapidly in and out of the cut, and it was able to work on soft ground without difficulty. The machine was then fitted with a No. 51 backhoe attachment, the removal of the counterweights and the fitting of the backhoe taking approximately 15 minutes from start to finish. The same time was required for removal of the attachment and the re-fitting of the counterweights. The bucket in operation had a width of 22 in. which could be increased to 24 in. A variety of bucket sizes is available up to 38 in. wide.

Approximately 20 dealers have been appointed throughout England and Wales, and similar arrangements are being made in Scotland. A service organization and spare parts facilities are being built up rapidly and already 90 per cent of the spare parts for the loader are available.

T.E.C. 206 for further details

The Ulster Flexite.

Carriageway Definition

In modern highway design the trend towards flush concrete kerbs, or concrete haunching to define the boundary between the carriageway and the hard-shoulder, has raised the very difficult problem of defining the edge of the carriageway at night. It is especially difficult during fog or light falls of snow. Since a driver is guided mainly on what he sees, the visibility aspect is probably the most important, and marking effective in thick fog must incorporate an efficient reflector. Moreover, the reflector must be easily cleaned and should be high enough not to become obscured in muddy conditions. A wet vertical element always reflects back to the driver much more light than a wet horizontal element and, therefore, the obvious choice is a small vertical post carrying a reflective element. This post must be robust and sufficiently flexible to permit a vehicle or cycle to drive over it without causing damage or injury.

A Belfast and Glasgow firm have now devised a flexible rubber post called the Ulster Flexlite, which appears to meet all of the above requirements. It incorporates a helical core spring in the rubber post to increase flexibility and also to prevent removal of the post by cutting. The reflective strip on these posts can be cleaned speedily and cheaply using a mechanical attachment to a tractor. The posts are 1¼ in. x 1 in. section and are 15 in. or 18 in. long, They are made of rubber or neoprene and are keyed at the bottom to allow secure fixing in concrete, either between or behind the kerb or haunching. An aluminium cap 4½ in. long is moulded into the posts to take a strip of Scotchlite 4 in. x 1 in.

A trial length of these posts was laid on a new length of roadway in County Down last September. The length is approximately two miles and they have so far proved successful.

T.E.C. 207 for further details

TEC520 for further information

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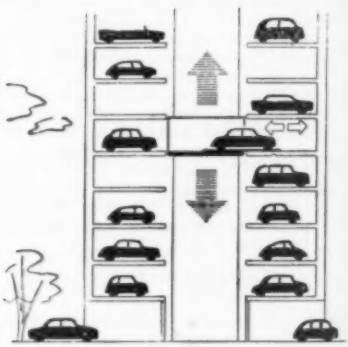

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